Vol. XXXI, No. 3 *Whole No. 266*

MARCH, 1931

SCHOOL SCIENCE AND MATHEMATICS

FOUNDED BY C. E. LINEBARGER

A Journal for all SCIENCE AND MATHEMATICS TEACHERS

CONTENTS:

Published by THE CENTRAL ASSOCIATION OF SCIENCE AND MATHEMATICS TEACHERS

Publication Office: 404 N. WESLEY AVE., MOUNT MORRIS, ILLINOIS

Business Office: 3319 N. FOURTEENTH ST., MILWAUKEE, WISCONSIN

Editorial Office: 7633 CALUMET AVE., CHICAGO, ILLINOIS

Published monthly, October to June, Inclusive, at Mount Morris, Illinois *Price, $2.50 Per Year; 35 Cents Per Copy*

Entered as second-class matter March 1, 1913, at the Post Office at Mount Morris, Illinois, under the Act of March 3, 1879

School Science and Mathematics

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TEXTBOOKS OF ELEMENTARY SCIENCE.

By W. Whitney.

A textbook of Botany has recently come to the Departmental Editor for review which has started him on a line of thought which seems worthy of presenting here. The book is entitled "Elements of Plant Science." The title chosen for this book correctly reflects the author's treatment of the subject. It is a science of elementary botany and no more. The numerous applications of botany in the everyday life of men are briefly pointed out in their proper relation to the topic under discussion, but that is all. There is no attempt to develop the practical or applied side of botany —this being left to the teacher in class room discussions.

In recent years authors of high school science texts have padded the books with much matter relating to practical applications of the subject, even going so far as to use the word "practical" in the title. We wonder if this has not gone too far and whether it is not time, now, for two types of books, one a real elementary science—merely pointing out practical uses as the work proceeds, and the other type a really practical text, not a mixture. For example it might be called a botany of domesticated plants, or more broadly, plants in their relation to man—treated with a scientific basis, of course. The latter type of book would be suited to agricultural schools, or high schools in strong agricultural districts. Perhaps there is room and need for these two types of elementary science.

A STATE DEPARTMENT OF EDUCATION MOVES TO IMPROVE SCIENCE TEACHING.

Mr. W. L. Downs, Georgia State High School Inspector, in a recent letter sent to Georgia science instructors, high school principals and school superintendents, touches upon a fundamental difficulty with science teaching not only in his State but in practically every other State in the Union. It is the unattractive condition of so many laboratory-rooms, where science tables are not kept clean, and apparatus and materials are left scattered about without proper care. His letter given below deserves the serious thought of every school man.

Experienced teachers have long known that the condition of a room, and its tidiness and general attractiveness of appearance, has a direct reaction on the pupils. A neat tidy room encourages neat thorough work, an untidy room encourages slovenliness. Pupils will not be interested in the science laboratory work unless the laboratory is kept in a tidy condition. It should be equipped with well built furniture especially designed and built by laboratory furniture experts, and the furniture should be cleaned by each class at the end of the period so that it will present an attractive appearance for the next class. Storage cabinets should be provided for apparatus and supplies. The apparatus must be cleaned when the pupils are through for the period, and returned to their proper place in the cabinets.

Mr. Downs' letter is as follows:

"Science is not well taught in a large per cent of Georgia's high schools. Much money has been spent in equipping laboratories. This equipment is abused and neglected. A large per cent of failures in college freshman classes were, last year, in science.

"We want to make an effort to strengthen the Science Departments in our high schools. No one can do this better than you. We are going to make some suggestions which, if carried out, we believe will contribute greatly to the success of science as a part of the high school program of studies. Through your cooperation we believe we can change the atmosphere of the Science Department. On the sheet enclosed will be found the suggestions we wish to make. May we have your closest cooperation?

"We shall be glad to have a report from any school that is making a special effort to strengthen the Science Department. Tell us what you are doing. We will pass it along so that others may be benefited."

The enclosure mentioned is given below:

1. So many of the laboratories are sadly neglected. There is no system in classifying and arranging the equipment. There is a grand jumble of everything. I go into laboratories well supplied with

apparatus, but unkept. During the year deterioration goes on at a rapid rate. Very often I hear a science teacher say that he found the remains of an excellent laboratory when he began work in a certain school.

2. Clean up your laboratory immediately. Have a place for all the equipment and keep all of it in its place, when not in use. Classify apparatus as to Biology, Chemistry, Physics. Make an inventory of all equipment now and check it at the end of the year.

3. Keep your laboratory clean and orderly every day. Recently I went into a laboratory where two classes had already used the room, but everything was as orderly as could be found in the best Home Economics Department.

4. If your equipment is meagre make plans to add to what you already have, but do it wisely. Go over carefully all experiments to be performed and check material in laboratory and buy only that which is lacking.

5. Visit the laboratories in other schools and look for suggestions that may help you.

6. Make your departments so interesting that more pupils may enroll next year.

7. Keep up with all the scientific developments. This can be done by reading scientific magazines and scientific departments of most current magazines.

8. Make Science a vital part of the school program. The responsibility is on you, teachers.

9. Let's point to our Science laboratories and departments as a whole with pride each day of the year.

10. Note the needs of the laboratory from month to month. From these notes determine next year's purchases.

THE C. A. S. & M. T. RECEIVES VALUABLE GIFTS FROM PAST PRESIDENTS.

Acting for the officers and the members of the Central Association of Science and Mathematics Teachers the president acknowledges with most hearty thanks the following gifts received within the past year. From Past President Clarence L. Holtzman, Principal of the John Lathrop Motley School, Chicago, several volumes of *School Science And Mathematics*. From Past President James H. Smith, Assistant Principal of the Austin Senior High School, Chicago, a number of year books and back numbers of the journal. From Past President H. E. Cobb, Professor of Mathematics at Lewis Institute, Chicago, bound volumes of the year books from 1902 to 1912.

These yearbooks and journals are valuable to the Association both in preserving the records and in providing libraries with complete sets. Some of these volumes are almost priceless because they are rare and in demand by educational institutions.

GLEN W. WARNER, *President*,

Central Association of Science and Mathematics Teachers, Inc.

PHYSICS AS A CAREER.

By Charles C. Bidwell,
Lehigh University, Bethlehem, Pa.

The purpose of this article is to call attention to the varied and increasing opportunities in the field of research for young men who are interested in science and who when so informed might have the determination to prepare themselves for scientific work.

The Growing Number of Research Laboratories: The recognition of the economic value of scientific investigation and the realization that growth and expansion follow upon research has led to the establishment of research laboratories in every field of industry and has resulted in a demand for trained personnel which at present far exceeds the supply. Scientific research has assumed an importance as a basis of industry equal to the exploitation of natural resources and must in the future become increasingly important as natural resources diminish. The amazing expansion in the electrical industries is to a very large extent the result of research. The statement applies more or less to every major industry, among the products of which we may list the telephone, the automobile, the airplane, the radio, talking movies, optical glass, scientific instruments, etc. Even the mining industries primarily exploiting natural resources, are developing through scientific research uses and needs for their products which did not exist before.

Keeping pace with the industrial needs of the country the research laboratories of the government are expanding at a corresponding rate. Such are the laboratories of the Bureau of Standards, the Bureau of Mines, and the Naval Research Laboratory. In the educational field the universities have reflected the spirit of the age in the expansion of research facilities and in vastly increased research productivity. The interest in research is such that publication of the results of investigation is taxing the capacities of the research journals of the country. In every field of industry, great or small, in government service and in education there is an insistent demand for men trained in the methods and technic of research, men with a more thorough training in fundamental science than the specialized engineer has time or opportunity to acquire in a course crowded with technical subjects.

These conditions have arisen so recently that students in our schools and colleges are largely unaware that they exist. As a student surveys his opportunities for a life work, engineering signifies to him the spirit of the age. He reads of wonderful achievements in telephony, radio and television. Brilliant nitrogen-filled lamps and glowing neon tubes excite his wonder. He is curious about the photo-electric cell and the remarkable things it can do. These are achievements of the research laboratory, in large measure the work of the physicist. Many students select engineering because of their interest in just these realms, whereas pure physics would lead them more directly into the field of their interest.

The work of the physicist requires not only special training but a special aptitude, an inquiring type of mind and an insatiable curiosity. The investigator is an explorer and not all men are born explorers. There are plenty of students, however, who could qualify for a research career who do not know that opportunities in this field exist.

Opportunities for the Physicist: Three avenues open to the trained physicist, (1) he may enter an industrial research laboratory; (2) he may enter one of the great government laboratories; (3) he may become a university teacher and investigator.

(1) *Industrial Research:* The industrial field is absorbing most of our physicists. Indeed the demand is so great that the government laboratories are finding it increasingly difficult to retain their new recruits, for many of whom government employment is but a training and a stepping stone to more highly paid positions in the industries. To quote Dr. W. R. Whitney, Director of the General Electric Laboratory: "It is a noteworthy fact that in recent years the industries in all countries have taken part in scientific work and have employed a rapidly increasing number of engineers and scientists . . . . Interest in new knowledge is no longer confined to the universities . . . . It is becoming the deliberate habit of industries to support the sciences on which they are based."

In describing the research and research facilities of the General Electric Company, T. A. Hawkins, Engineer with this company, says: "One of the primary purposes of the research laboratory is to glean from the field of science prin-

ciples and ideas that industry may make of practical value to the world and the world's material work. Another is to seek the solution of problems in manufacturing processes, production and similar matters." He mentions among the achievements of the General Electric Laboratory, the Coolidge X-ray tube, which has entirely supplanted the earlier types and furnished the medical profession with a tool of inestimable value; the gas-filled incandescent lamp, which had its origin in an academic study of the laws governing the loss of heat from small wires and an investigation of the evaporation of tungsten; the metallized filament lamp, which resulted from experiments with a high temperature vacuum furnace; the Coolidge cathode ray tube, applications of which have still to be made; the atomic hydrogen torch yielding temperatures 1000° hotter than the oxy-acetylene flame; the Langmuir pump, which produces the highest vacuum known. "In none of these cases were the practical results forseen when the research that made them possible was started. Not all important achievements, however, have been thus brought about. Many of them, of which drawn tungsten wire is a notable example, were the result of persistent and resourceful effort directed from the beginning toward a perfectly definite goal." The same authority in another article says: "It is the emperious desire for knowledge, for exploring the unknown, that actuates the research scientist whether in a university or in the industrial laboratory. Science on the one hand has pierced to the heart of matter through the atom to the electron and proton, the smallest of existing things, and on the other has swept beyond the limits of the stellar universe, in which our solar system itself is an insignificant atom, out to other universes more than a hundred million light-years away. Chemistry has been rewritten and a wholly new physics created. And in consolidating the gains of this scientific advance the workers have found the means for profoundly modifying one industry after another."

Expansion and development through research was typical of German industry before the war and Germany led the world in scientific achievement. But American industry is now taking the lead and this leadership can only be maintained by constant research looking to improvement in prod-

uct and extension of knowledge. Speaking of the changed outlook Frank B. Jewett, President of the Bell Telephone Laboratories, says: "Twenty-five years ago we came to the realization that engineering unaided was incompetent to cope with much that pure science research was bringing to light. In different fields and different industries this need for an enlarged attack evidenced itself. From small and timid beginnings, two decades have seen the growth of great industrial laboratories, which in many instances have come to be the central nucleus about which the whole commercial machine revolves."

As to ultimate attainment in the industries, it is the common experience of research men to reach ultimately positions of high executive and administrative responsibility. The research laboratory is a direct route to such advance. The thorough training in fundamentals coupled with the specialized knowledge obtained through research are the best qualifications for administrative work in connection with the products of research.

(2) *Government Service:* The Bureau of Standards has become the greatest governmental research laboratory in the world. Its work is not confined to standardization but covers nearly every field of scientific endeavor. Of the purpose and functions of this laboratory, Bureau of Standards Circular No. 1 says: "Research on problems arising in connection with standards is by act of Congress a primary work of the Bureau. Progress demands new kinds of measurements, new standards, and ever increasing accuracy. These with their far-reaching details demand research at every point. Research is essentially pioneer work. Pure research in science is the fabled goose that lays golden eggs. Its gains are best when new knowledge is the aim unharassed by pressure for instant use. The Bureau has kept alive its pure research in science side by side with its industrial research. Many uses are found at once for new research results, in fact so many uses that the Bureau must leave to others the full application. Hundreds of researches are in progress in this one laboratory ranging from a few days duration to a year or more. Originality, expert knowledge, and skill are required in every case."

The Naval Research Laboratory, a development from

an emergency war laboratory, is carrying on researches over the whole field of physics, from studies of the Heaviside layer in the upper atmosphere which prevents the escape of our radio waves, to the application of sound echo methods for determining the topography of the sea bottom.

The Weather Bureau, the Bureau of Mines and the Coast and Geodetic Survey are employing physicists in ever increasing numbers. The Geophysical Laboratory of the Carnegie Institution is a semi-government laboratory which employs many physicists covering a wide field of research.

(3) *The Educational Field:* A bulletin of the National Research Council says: "The number of teachers required for our colleges and universities has grown with the rapidly increasing number of students. From educators we learn that the demand for an increase in educational facilities is not occasioned by a temporary interest but by a realization of the value of education and by a response accentuated through the adjustment of our educational institutions to the more obvious needs of the people." The interest in scientific research on the part of the industries and the demand for trained research men have reacted upon our universities, giving a tremendous impetus to research. "In the large educational institutions the teacher is an investigator who may select for study whatever field he chooses. He is free to choose for investigation any problem that catches his interest and fires his imagination."

"In every line of activity of the physicist there is thus an indication of a permanent and increasing demand. A physicist may be a teacher, he may combine teaching and research, he may devote himself to investigation, to development or to a combination of the two, or he may become an administrator in industry." His opportunities are almost boundless and his attainment is limited only by his ability.

COLORADO THE HIGHEST STATE.

Colorado is the highest State in the Union, its average altitude above sea level being 6,800 feet, according to the Geological Survey, of the Interior Department. Wyoming is a close second, with an average altitude of 6,700 feet.

The highest point in the United States is Mount Whitney, California—14,496 feet—which is 76 feet higher than Mount Elbert, Colorado, the second highest mountain.

The highest pass in the United States is Whitney Pass, California, 13,335 feet above sea level.

ON TEACHING LIVING BIOLOGY.

By F. A. Varrelman,
The American University, Washington, D. C.

Courses in biology as taught today in high school and college vary materially. As Nichols[1] points out, among colleges where no biology department exists, the course is taught under the direction of the zoology department, and the botanical side of the subject is entirely neglected, or is satisfied, as I have observed in one Eastern college, with a sprig of fern and some pleurococcus. There are, it is true, too few teachers versed in both botany and zoology to teach real biology, but surely some program of harmony could be worked out between botany and zoology teachers to give students the benefits of both sides of biology in a one year course. Few students, not majoring or minoring in biology can afford to spend more than one year on this subject, and yet meet the major or minor requirements in the fields of their own choice. It is truly sad to have a student either elect botany and be unfamiliar with the functioning of his own animal body and unable to recognize and understand the animals of his surroundings, or to elect zoology and miss the joys and inspirations received in identifying and understanding the whys and wherefores of plants. It is true, men may become highly successful in many walks of life without a knowledge of the structure of protoplasm, or of the reproduction of spirogyra, but do they have the fullest appreciation of the nature about them? Certainly education should contribute something to an appreciation of the aesthetic and the deriving of inspiration from the world of living things.

Though some biology courses are undeniably successful, there is, however, much *dry rot* in biological courses, as Wheeler[2] states. There should be a "Back to Nature" movement among biologists. By cutting out fads and fancies, a single biology course could be given which should contain more old fashioned natural history or ecology, more knowledge of plants and animals and less of their detailed insides, enriching the student's life by

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[1]G. E. Nichols, Science, 50:509-517, Dec. 5, 1919.
[2]W. M. Wheeler, Science, 57:61-71, Jan. 19, 1923.

a closer association with the life about him. Is it not strange that those living things, with which we are most closely associated, human beings, birds, domestic animals, insects, and flowers are largely omitted from our text books on biology, botany, or zoology? Biology courses dealing almost entirely with the functions[3] of animals, or plants and animals, unfortunately are replacing courses dealing with plants and animals themselves.

A serious criticism of such functional courses in biology, is that they are of as much value as freshman chemistry courses, they are but a means to an end, not an end in themselves[4]. A biology course should be taught as an end in itself. Too often our freshmen courses are planned for premedical students, or for students who will become biologists, not for the vast majority who will never study biology courses again. By giving a practical, working education in plants and animals (including the human), in the introductory course the student's interest in living things will be maintained in after life. To attain this it must be done in one year, for Koos[5] shows that less than 10% of the students taking the first year course go on with that subject.

Shull[6] believes that natural history should be taught in the high schools[7]. I agree to this and add—continued in college. Not all students study biology in high school[8]. Until high schools teach a natural history course, and all students are required to take it, the introductory course in college may well be natural history. Some repetition will do no harm, for though there is much overlapping of college courses on high school courses, the

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[3]A friend of mine, teaching a thousand freshmen annually, gives a course using a text which has no reference to, or illustrations of, plants or animals as entities; except for permutations and combinations of genes, and some philosophy of evolution, the whole text content is chemistry, of protoplasm, of nutrition, of muscle action, and of nerve action. I admire such a course. I am requiring advanced students majoring or minoring in biology to study that text, but I do not believe such a course desirable for freshmen. Having completed that course, freshmen may know the chemistry of respiration and digestion but not the plants or animals in which such processes take place.

[4]I advise all students majoring in biology to take as much chemistry, physics and mathematics as possible, and require a minimum of a year's credit in chemistry of students majoring in my department.

[5]Koos, Junior College, U. Minn. 1924.

[6]A. F. Shull, School and Society, 21:425, Apr. 11, 1925.

[7]Teachers will agree that students with several units of high school biology credit are not really better college biology students.

[8]I find that less than 50% of the students taking college biology have had high school courses in this subject.

former present the subject much more intensively and extensively. A course in biology which will be of use to students in after life, is a course which ". . . should enable a person to live a more wholesome[9], healthful life, have a better understanding and kinship for other living things, and have a higher regard for the betterment of his race among other animals."

What should be the content of a course to fulfill these requirements? 1. Self knowledge, 2. Philosophy of the universe, 3. The environment.

1. SELF KNOWLEDGE.

Certainly the maxim of the Temple of Apollo at Delphi, "Gnothi Seauton" (know thyself), will be conceded by all as of paramount importance. Yet aside from vague references to the human animal, few biology or zoology texts give reference to human anatomy or physiology. Human beings are interested in knowing how they are built and how they work inside. True they may not care for a detailed account, but they do want to know the working principles. In this age of enlightenment, as in all ages, men and women are interested in the anatomy and physiology of their own and of the opposite sex. They want to know the hygiene[10] and physiology of reproduction, human embryology (the chick is interesting but far from satisfying), and the special physiology of the child and mother in child bearing. No introductory biology or zoology texts have any reference to these sought for facts. Too many zoologists contend they belong to the field of anatomy and physiology. Henderson[11] for this reason believes the beginning course in biology should be physiology. As most of the anatomical and physiological structures are demonstrated on other animals than humans, there is no reason why a biologist or zoologist should not give this instruction with the animals studied.

The subject of anatomy and physiology of mammals with human applications is fundamentally a laboratory

[9]R. H. Walcott, Science, 48:520-529, May 31, 1918, discusses at length the aesthetic values of biology.

[10]I find Meredith, Hygiene, Blakiston, 1926, chap. 25 and 43 the best presentation of sexual hygiene.

[11]Y. Henderson, Science, 51:64-65, Jan. 16, 1920.

study. It is best developed by working out the systems on a mammal[12] and comparing with the human throughout, using charts and models, skeletons and manikins. Preserved museum specimens of fetuses, one showing the fetal membranes, afford a great interest. A medical museum will also prove of great value in this teaching.

2. PHILOSOPHY OF THE UNIVERSE.

Next to a desire to know about one's self, comes a desire to know about other people, other races[13]. How different are the other races? Why are there different races? Where did these races arise? Seeing similarities between the self and other animals the question arises are we related? These are fundamentally questions of philosophy, called by the Germans "Weltanschauung." They, however, have a legitimate place in a course in biology. The philosophical problems involved are the theories of evolution, theories of the origin of the earth, and of life on earth, and the history of life on earth, the paleontological sequence, and the harmonizing this with the complexity of plant and animal forms. The methods of evolution including genetics (and selective evolution, eugenics) cover the essentials of the philosophy of the universe.

This subject is purely one for the classroom and museum, with rare excursions into the laboratory. The laboratory problems are purely those of rationalizing on comparative or vestiginal structures, and the possible breeding of the fruit fly, Drosophila, to illustrate Mendelism.

3. THE ENVIRONMENT.

The youth of the eighties knew birds. The youth of

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[12]I find the fetal pig the best mammal for study. As Baumgaertner, The Fetal Pig, Macmillan, 1927, says, they are easily obtained from the local abattoirs; they are fresh, and cheap, and do not necessitate a special killing for dissection. In addition, as the complete uteri are removed from sows, these may be taken to the laboratory to show all fetal membranes, a thing fascinating to all students. Fetal circulation may well be seen, and the normal natal circulation worked out. These pigs, studied and continuously compared with manikins, are an interesting and useful lesson.

[13]T. W. Turner, School Science and Mathematics, 27:681-684, Oct. 1927, believes there is a danger of engendering race hatred or superiority complexes by teaching about races. I wonder whether the Japanese ethnologists place the Caucasian race at the top of the scale. Considering the vast history of civilization existing while most Caucasians still lived in caves, I marvel that the Caucasian dares place his race above the Mongolian. Nordic superiority hates to admit that Hindus are of the white race.

today knows motor cars. Does the youth of today get as much thrill out of hearing the chug of a Buick as the youth of yesterday got out of hearing the per-chic-o-ree of the goldfinch? Life today is far more complex and extensive than it was in the eighties, but should we sacrifice the studies of the beauties and grandeurs of nature for the commonplaces of the street? Is it not as desirable that one should know "how to find one's way about the world of nature" today as it was for our ancestors[14]? Let general science and physics contribute to an understanding of gasoline engines and radios, but let biology adhere to the study of recognizable, living things.

Environment, biologically, according to the *Century Dictionary,* is "the sum of the agencies and influences which affect an organism from without." Rapid transit has immeasurably extended our environment both in taking us to new contacts and bringing new agencies and influences to us. Environment, then, includes plants and animals that affect the health, food, shelter, clothing, and emotions of man. To include all of these in a course of biology is a large problem, but certainly many forms under these categories can be included. Health and emotions are the two that contribute most to one's happiness; hence animals and plants affecting health and emotions should have a priority claim and, where time permits, those concerned with food should be included. It is amusing to know that few people are interested in zoological aspects of food—that vinegar usually contains round worms, or figs contain larvae, pupal cases and adults of small hymenoptera, while they are much interested in knowing that tomatoes are berries and raspberries are not, enjoying nearly all botanical relationships of food. Almost everyone is interested in the animal or plant source of medicines.

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[14]Dr. C. Hart Merriam at the meeting of the National Academy of Sciences at Washington, April 29, 1930, told of asking an Indian woman in California for two kinds of manzanita known to be growing there. The Indian said that there were three kinds. Dr. Merriam questioned, surprised, but asked to have samples of each. The woman spoke to her five year old daughter who went into the woods close by and soon returned with three kinds of manzanita. Dr. Merriam described this third, heretofore unknown species. The Indians knew three. The botanists knew two. Dr. Merriam contrasted the knowledge of the youth of today with that of the Indian in plant lore, to the great discredit of modern youth.

Contrast with this the squib, "The Botany Exam." by Robert Benchley, in the New Yorker, June 14, 1930, in which he deplores the labelling of plants along a nature trail in Central Park, insisting the labels and questions are a challenge to his ignorance, and so have caused this walk to lose all the charm it had in prelabelled days.

The flora and fauna of the intestine, the gutter, the ditch, the swimming hole, the pond, the vacant lot, the parks, the countryside, should be of interest to all. And certainly insects, man's greatest competitor for the supremacy of the earth, should have more than a passing word, and our heavenly messengers, the birds, should be discussed as man's greatest aid in his maintaining the supremacy over the insects. The recognition and understanding of animals and plants, native and introduced, with a definite aspect of conservation, should be the context of the study of environment.

To study plants and animals in their interrelations is to study ecology, a living biology. This ecological plant and animal study should be the most extensive part of the introductory course in biology. How can a living biology be taught? How can we return to nature? Many colleges exist in cities. All colleges are in session during that period of the year when most nature is resting. Teaching under such conditions demands recourse to two possibilities: (a) we may bring nature to the laboratory, (b) we may depict nature. A third, the ideal, is (c) go to nature.

(a) Colleges have been loath to make their laboratories attractive and interesting. The high schools usually set a better example, and so practice a better pedagogy. By having terraria, aquaria, observation apiaries and formicaries in the laboratory an attractive, interesting room is produced, and living things have been brought to the laboratory. It would be well to have a greenhouse in conjunction with the laboratory, but should this be lacking, the class may advantageously visit some local florist, there becoming familiar with introduced plants and observing the algae, mosses, liverworts and ferns growing about on the walls, and under the benches, and on the sides of the flower pots. It is usually possible to find all stages of these plants at this time. Botanical gardens and parks are of use to city colleges for spring and fall study.

(b) Depicting nature has been the most frequently used method of teaching biology. Charts, photographs, lan-

tern slides, motion pictures[15] and museums all illustrate nature. Some of these may well be used to give a preliminary training for field work resorted to when the weather permits.

(c) For the best study of living things classes should go to nature. For such ecological study, field trips, biological stations, educational camps, and National Parks offer good opportunities.

Field trips to parks, botanical and zoological gardens, aquaria, woodlands, and marshes take students to nature where many phases of biological types and problems may be exemplified. Biological stations located in every section of the country offer an excellent opportunity for certain phases of natural history study; particularly is this true of the freshwater and mountain stations which are of more recent origin than the marine stations[16]. Likewise they are better equipped to handle undergraduates than the marine stations. Educational camps, offering college credit, conducted by some colleges, give excellent work in nature study rather than natural history. The New York State Museum and the University of Buffalo maintain the Allegany School of Natural History in the Allegany State Park offering excellent natural history work. The National Park Service has in the past few years maintained an educational division. Naturalists are located in the larger parks to explain the *raison d'etre* of all within the parks. They conduct field trips to various parts of the park to illustrate the geology, dynamic and historical. They also point out the ecological groupings, so beautifully portrayed in the gradations into zones of life, natural plant communities with nearly fixed fauna, avian, mammal, and insect, up the mountain side beyond the timber line.

The National Parks are undoubtedly our greatest natural history laboratories. As they count their areas in hundreds of square miles, whereas biological stations count theirs in acres, the opportunity for the study of the primitive ecological relationships is nearly limitless.

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[15]The U. S. Dept. of Agriculture lends without charge many excellent films of National Parks, plant introduction, insects, etc., having ecological or other biological value.

[16]The General Biological Supply House, Chicago, annually publishes a list of Biological Stations and Nature Study Schools.

To attain a better nature-training in biology, colleges should encourage students to use one of these "Go to Nature" methods. Much can be learned even in two weeks, and some method should be devised of arranging credit for students passing an examination on the ecological precepts brought forth in a two weeks' trip with a Park Naturalist.

College biology departments, as many geology departments have done for a number of years, should conduct more directed natural history trips through the National Parks for college credit. Students majoring in biology should know something of nature and be required to attend such a trip for a rounding out of biological training. As these parks contain museums, and are developing libraries, and will undoubtedly soon provide laboratories, these parks should become our greatest natural history schools, open for use to all schools and colleges.

HOW CAN WE PLAN SUCH A COURSE?

A course in ecological biology, must of necessity, follow the seasons. The ideal time to start the course would be in the spring quarter, and run it through the summer and fall quarters, and possibly also the winter quarter to round out the anatomy and physiology. That plan, though it is ideal is impracticable because convention demands that courses start in the fall, and more colleges work on a semester plan than on the more desirable quarter basis. Few schools, if any, demand summer attendance. Furthermore, many schools must accommodate entering freshman at the beginning of the second semester. To meet such conditions the course herein outlined, is planned[17].

Accordingly, the course is divided into two interdependent parts, either may precede the other. The fall being a better time to collect insects, and the winter preferable for animal dissection the first part of the course is called Ecology of animals. The spring being a better time for the study of plants as most are flowering at this season, the second part is called Ecology of plants.

Of the first semester, the first three or four weeks of

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[17]This is a 5 hour course given throughout the year, two 2½ hour laboratory periods, two 1 hour lecture and one 1 hour quiz periods each week.

the laboratory periods are devoted exclusively to field work. Students study and collect insects, wild flowers, autumnal leaves[18], and observe birds. Inclement weather is used to study anatomy and homologies of insects, arachnids, and crustacea. Bird study is also an out-of-class assignment. A student is expected to be able to recognize twenty-five birds.

About the first of October students make infusions of whatever they desire, and later bring in cultures from ponds, springs, brooks, ditches, etc. These are ready for study about the middle of October. Then the algae, fungi (molds and bacteria), protozoa, plathelminthes, nemathelminthes, trochelminthes, microscopic annulates[19], and arthropoda, are identified, food habits and reproduction studied. If time permits sponges (freshwater and bath), hydra, obelia, and jelly fish (sea nettles) are given a week of study. Following this three laboratory sessions are devoted to mollusca, oysters, clams and snails. Oysters and clams are studied simultaneously, snails subsequently.

The two or three laboratory sessions before Thanksgiving are given over to comparative osteology, skeletons of fish, amphibia, reptiles (lizard and turtle), birds, and mammals (rabbit, dog, pig, monkey, and man). Homologous bones of the skulls are similarly colored. Students are provided with diagrammatic skeletons of frog, chicken, pig, and man; they label the bones on all charts and merely observe the skeletal homologies of other animals[20]. During the remainder of the semester the students are dissecting both frog and pig and making a comparative study of each with the other and with models of man.

Cultures brought in in February from frozen ponds, brooks, etc., grow actively, and afford another opportunity to review the animals previously studied, and em-

[18]Autumn leaves are held over for spring herbaria.

[19]The earthworm and pileworm are studied in this connection.

[20]We have for many years preached about the training value of a course in biology, but most psychologists will agree that formal training is a myth. To train a man to dissect, observe, and draw in detail the nervous system of a crayfish will not in the least enhance his technique or observational powers as far as other non-biological things are concerned. By creating an interest in things biological a carry over value is effected, but only so far as the interest in things biological is concerned. Opalograph drawings of most of the dissections are given to the students thereby saving the time otherwise devoted to unprofitable drawing.

phasize the botanical aspect of such cultures, showing also an interesting change of dominance of flora and fauna in the two seasons. Moss and fern spores planted on moist bricks under bell jars give early moss and fern study material. A trip to the neighboring florist shows prothalli, mosses and liverworts (to be had for the asking) growing on the walls and under the benches. It also offers an opportunity to show plant propagation, as well as acquaint the student with some commercial varieties of ferns and flowering plants.

Plant anatomy and physiology will then prepare them for the beginning of spring, when they again go into the field to watch the succession of wild flowers and record the birds as they appear from their winter migrations. Collections of spring flowers are made, but conservation is strongly emphasized (plants which would die as a result of removal of leaves and stems are not touched, and no roots are ever disturbed). The botany of the commercial fruits and vegetables provides the material for laboratory study on inclement days, thus attempting throughout to introduce the student to the plants and animals he meets in his later life, directly through rural contacts, indirectly through food, medicines, apparel, etc.

As the exercises are discussed at the close of each laboratory period, and as a whole period a week is set aside for quiz and discussion, the lecture work does not always run concurrent in subject matter. Hence, the first few weeks when students are in the field the subject of lectures is "The field of biology," (zoology in particular), and the scheme of classification of animals. The structural and physiological facts of particular forms are discussed in the laboratory, the economics (food, medical, and technical) and zoological relationship in lecture. The arthropods, micro-invertebrates (protozoa, plathelminthes, nemathelminthes, trochelminthes), annulates, mollusca, classification of vertebrates, orders of local birds, all orders of mammals, paleontology, evolution, genetics, reproduction, sex hygiene, make up the topics of the lectures of the semester.

The same procedure is followed in the lectures on plants. Attention is called to the natural plant communi-

ties caused by similar soil, hydrogen ion, climate, light or shade, and water demands. Especial emphasis is placed on the medicinal, food, technical and aesthetic values of plants.

Throughout the course the criteria of instruction are: 1. Will you recognize it if you meet it? 2. Where do you expect to meet it? 3. What is its value to man?

NEW INSTRUMENT MEASURES RADIO INTERFERENCE.

Squeaks and squeals and other forms of radio interference can now be measured in terms of electrical units with an instrument developed in the laboratories of the General Electric Company.

The instrument which can be readily moved from place to place, is called the radio noise meter. It measures in terms of micro-volts per meter electrical interference which is made audible to the ear only by a loud spaker or radio headphones.

With this apparatus the magnitude of radio noises on transmission lines and house wiring, and around distribution points or electrical apparatus of any kind can be accurately found. It is expected that one of its uses will be as an aid to police authorities in communities which have passed ordinances protecting radio listeners from excessive electrical interference.

The instrument is composed primarily of a radio receiver to pick up the interfering signals and a calibrating unit which generates standard signals for comparison with the unknown interference. Operation consists in adjusting the intensity dial until the standard noise reads the same on the meter as the radio noise. The intensity in micro-volts per meter is then read from a curve.—*Science Service.*

SUMMER COURSES AT TEACHERS COLLEGE.

Teachers College, together with other divisions of Columbia University, offers to teachers of science, through the Columbia University Summer Session of 1931, four unique opportunities for study:

(1) Professional courses in the teaching and supervision of science work in elementary and secondary schools and in teacher-training institutions.

(2) Subject-matter courses devoted exclusively to study of content in each of the major divisions of science.

(3) An intersession course for the convenience of those who desire to extend their summer study to include the period between the Spring Session and the Summer Session.

(4) A field course of six weeks in Germany, given during the period of the regular Summer Session, for the study and observation of the work in science and science education in that country.

In constructing programs in Teachers College for the degree of Master of Arts or Doctor of Philosophy, students may divide their efforts between professional and content courses. Opportunity is offered for them to follow their special interests. The work has been so planned that students who are interested may acquaint themselves with the recent developments both in the field of science and in the field of professional training.

THE SELECTION OF MATHEMATICS TEXTS IN THE JUNIOR HIGH SCHOOL.

By ROBT. L. WILLIAMS,
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I. THE PROBLEM

The Junior High School movement in the United States has developed within the last thirty years. Prior to 1900 there were only two Junior High Schools in the United States. Since that time, however, the movement has grown until such writers as Koos[1] offer prophecies to the point that it will be a near-universal institution within the next twenty-five or fifty years. Whether this prophecy be fulfilled, or not, is beside the point. Any reader of present day educational literature realizes that the Junior High School offers problems in educational theory and practise that must be given a major amount of attention. This is particularly true of the Junior High School curriculum, of which the texts used forms an appreciable part.

The Junior High School maintains such an important place at the present time that many of the standardizing agencies of the country have set up standards to be met by this unit. Many of the standards mentioned refer to the curriculum. Among such agencies might be mentioned the North Central Association of Colleges and Secondary Schools. This agency has, within the last three years, published standards, both qualitative and quantitative, to be met by the Junior and Senior High School curriculum.[2] The Quarterly Journal of this organization for March, 1928, contains the objectives (standards) of the Junior High School Mathematics courses as viewed and accepted by the North Central Association. The subject matter that should be used to achieve the objectives mentioned is also outlined. While no one would claim that these objectives are the last word in the discussion of Junior High School Mathematics, they do possess value in that they have been accepted as the standards by an association covering twenty-two of the forty-eight states of the union.

Within the last five years several series of texts for use in Junior High School Mathematics have been placed on the

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[1]Koos, L. V.; *The American Secondary School*, page 40, Ginn and Co., 1927.
[2]Quarterly Journals of the North Central Association of Colleges and Secondary Schools; issues of March, 1927; March, 1928; March, 1929.

market. These texts, in most cases, claim to make special adaptation to the needs of the Junior High School student and to meet the demands of educational theorists in regard to the content of the subject matter for use in the Junior High School. *The purpose of this study is to outline a scheme for evaluating texts in order to enable the teacher to select, for class room usage, a series of books that contain material adapted to the avowed aims or objectives of the course.* For purposes of illustration, the aims of Junior High School Mathematics and several series of Junior High School Mathematics texts are used.

The importance of objectives in determining the content of courses is given lip service by almost every teacher in the land. Many, however, continue to use texts that contain material not adapted to achieving the avowed purposes of the course. This study recognizes that the North Central Association has adopted certain standards to be met by the courses in Mathematics offered in the Junior High School. The problem then becomes one of determining whether the texts offered for use in the Junior High School contain material capable of meeting the accepted standards. If the books meet these standards there should be a close correlation between the material offered in the books and the materials demanded by the objectives.

This study does not propose to offer the student a final answer to the question of articulation between objectives and subject matter. It purposes to outline a scheme of evaluation that may be used by a teacher regardless of her aims or the text used, in most Junior High School courses —whether it be Mathematics, History, or what not. When complete the study will have demonstrated anew the close relationship needed between subject matter and objectives, and, in addition, will have offered a technic for measuring the relationship demanded.

II. Method of Study.

The North Central Association objectives for Junior High School Mathematics are divided into the following headings: (1) Vocational Objectives, (2) Social Objectives, (3) Leisure Time Objectives and (4) Health Objectives. Under each of the above mentioned divisions are four subheads: (a) The acquisition of fruitful knowledge, (b) The

development of attitudes, interests, ideals, and appreciations, (c) Acquisition of the techniques of problem solving, and (d) The development of habits and skills. Each of the sub-heads has been assigned certain subject matter. The subject matter is supposedly that which will accomplish the end desired for that particular part of the objective.

The different phases of Mathematics mentioned in the objectives are classified as to subject matter. For example, the material for the attainment of the objective toward the acquisition of fruitful knowledge first mentions, "Knowledge of the extent of measurement in human activities." This is, in this study, classified under the general heading of Measurement. The entire list of recommendations were classified and placed under one of the eighteen headings contained in Column I of Table I. The number of times each particular heading is mentioned is totalled and translated into percentages to indicate the relationship existing between that particular heading and the entire group of eighteen divisions. For instance, Table I, Column I, Item I, "Business and Home Problems" has beside it 21.42%; which means that considering all the recommendations made by the North Central Association as 100%, 21.42% were concerned with this type of problem.

A similar procedure was used in classifying the material contained in the series of Junior High School Mathematics Texts. A unit of one-fourth page was used. That is to say, credit is not given a particular text, or series of texts, for containing a given type of content, unless at least one-fourth page is occupied by the material in question. The total number of quarter page units credited to each of the eighteen headings (Table I, Column I) is placed in a percentage ratio with the total number of quarter page units allotted the eighteen headings. Table I, Column III, Item I "Business and Home Problems . . . 14.63%" simply means that in the texts of Series A, 14.63% of the material related to the demands of the North Central Association was concerned with Business and Home Problems. Column II, Item I also indicates that the North Central Association accorded this item a valuation of 21.42%. This means that Series A lacks approximately 7% of having devoted enough space to the matter of Business and Home Problems as sug-

gested by the North Central Association standards. It is possible by this kind of comparison to determine whether the importance attached to any of the eighteen headings by the North Central Association is approximated by the writers of a given series of texts.

The study and its conclusions rest upon one fundamental assumption, namely, that the frequency of mention of items in the objectives of the North Central Association is representative of the importance attached to that particular item. A corresponding assumption is made regarding the relation of the amount of space to the importance of the items included in the series of texts surveyed. That is to say, the topics (Table I, Column I) mentioned most frequently as indicated by the percentage evaluation were considered to be the most important in the eyes of the curriculum committee of the North Central Association dealing with Junior High School Mathematics. Likewise, the topics receiving the largest amount of space in the texts were assumed to be of major importance in the eyes of the text book writers. Such an assumption, while possessing undoubted disadvantages, is not new to curriculum studies, being listed and evaluated in almost any worth while treatise on the matter of curriculum building.

Due to the fact that the report of the Sub-Committee on Junior High School Mathematics allows freedom in presenting the material with respect to the order of presentation within the Junior High School this study does not differentiate between the grades seven, eight, and nine. Rather the items are taken for all three grades together. Otherwise the difference between the series of books in regard to the order of material would present a difficulty that could not be overcome in a study such as this. Since this discrimination between the grades is not made for the objectives, or for the texts, no error is introduced.

There are two types of objectives in teaching Mathematics that cannot be evaluated in the manner outlined above. These objectives deal with the development of ideals, attitudes, and appreciations for one, and the development of concepts for the second. The inability of the examiner to evaluate these objectives is inherent in the subject matter itself. Almost any kind of material might be

used to develop attitudes, ideals, or appreciations. The examiner could not tell what interpretation might be given a certain part of subject matter in order to develop these attitudes, or subjective emotional reactions on the part of the pupil. For that reason the objectives in question were omitted from the study.

For the immediate purposes of this study three complete series of Junior High School Mathematics texts were chosen. Each series consisted of three texts, one for each of the grades seven, eight, and nine. The names of the texts are, quite obviously, not given. They were selected for their newness and their repeated claims to have been written for the Junior High School situation.

III. The Data.

In 1925 Gaardsmoe[3] surveyed the status of Mathematics in grades seven, eight, and nine. She reported that the material then offered was divided among the subjects of Arithmetic, Geometry, Algebra, Statistics, and Trigonometry. It was further reported that Arithmetic occupied a major part of the time in grades seven and eight and Algebra constituted the major piece de resistance of the ninth grade. That simply means that Junior High School Mathematics in 1925, while relatively new in name and claims for glory was simply a rehashing of the traditional offering of the Elementary School followed by Algebra in the first year of the Senior High School.

The present study does not divide Mathematics into Arithmetic, Algebra, Trigonometry, etc., as did Miss Gaardsmoe. Such divisions as measurement, graphs, formulae, problems, etc., were used, regardless of whether the subject matter is geometrical, algebraic, arithmetical, or what not. This was done because Junior High School Mathematics is supposedly General Mathematics and in the development of one mathematical ability, such as measurement, several of the different mathematical fields must be illustrated and brought to bear on the students' problems. The classification used in the present study (Table I, Column I) is similar to the one used as sub-heads for the objec-

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[3]Gaardsmoe, Alma C.; *Present Status of Mathematics in Grades VII, VIII, and IX.* Master's Thesis, University of Minnesota Library, 1925.

tives of Mathematics in the Second Yearbook of the National Council of the Teachers of Mathematics.

Referring again to Table I, it is seen that Column I contains the divisions of mathematical subject matter mentioned in the objectives or standards of the North Central Association, Column II contains the percentage of mention given each of the divisions by the North Central Association, Columns III, IV, and V contain the percentage of text book material given to the various mathematical divisions by three separate series of Junior High School Mathematics texts.

TABLE I—PERCENTAGE OF PAGE SPACE ALLOTTED TO DIFFERENT SUBJECTS IN THREE SETS OF JUNIOR HIGH SCHOOL MATHEMATICS BOOKS AS COMPARED TO THE PERCENTAGE OF FREQUENCY OF MENTION IN A REPORT OF THE SUB-COMMITTEE FOR THE OBJECTIVES IN JUNIOR HIGH SCHOOL MATHEMATICS FOR THE NORTH CENTRAL ASSOCIATION.

Col. I	Col. II	Col. III	Col. IV	Col. V
Divisions of Subject Matter	Percentage of Space Allotted by:			
	North Central Standards	Series A Texts	Series B Texts	Series C Texts
1. Business and home problems	21.42	14.63	12.84	20.51
2. Construction	8.09	8.71	4.74	4.45
3. Equations	8.09	11.34	10.70	9.03
4. Exponents	.95	1.64	1.52	.33
5. Formulae	8.57	4.44	4.58	7.91
6. Fundamentals of arithmetic	7.61	6.25	10.70	6.13
7. Fundamentals of algebra	.95	3.61	5.84	9.14
8. Graphs and statistics	10.00	9.04	4.74	8.80
9. Measurement	10.00	9.70	3.36	1.44
10. Problem solving	7.61	15.78	25.22	13.37
11. Products and factors	.47	1.97	3.51	3.12
12. Radicals	.47	1.31	1.83	1.89
13. Ratio and proportion	4.28	.98	1.22	1.67
14. Square Root	1.42	2.46	1.83	2.00
15. Signed Numbers	1.90	5.26	1.22	3.90
16. Tables	3.80	.32	.30	.33
17. Triangles	3.80	.82	3.66	2.89
18. Trigonometry	.47	1.64	2.14	3.01
Total Per Cent	99.90	99.90	99.95	99.92

r of Columns II and V = $.4352 \pm .1288$.
r of Columns II and IV = $.5218 \pm .1156$.
r of Columns II and III = $.6937 \pm .082$.

None of the North Central Association Standards were totally neglected in any of the series of texts. It is easily seen, however, that the importance accorded many of the

items by the text book writers does not agree with the importance accorded that particular item by the Sub-Committee of the North Central Association. A Products-Moment coefficient of correlation (r) was computed between the standards of the North Central Association (Column II) and the actual space given the standards by the various series of texts (Columns III, IV, and V). These figures show that there is some correlation, rather mild, between all of the texts and the standards of the North Central Association. Only one series of books, Series A, approaches the norms to such an extent that they would be considered usable for the purpose of achieving the objectives of this organization.

There are more than three series of Junior High School Mathematics texts that could have been evaluated. The use of three, however, is sufficient to indicate the procedure necessarily involved if one select the subject matter to be used in the light of the objectives to be achieved. That this is worth while is so well known that it is not discussed in this paper.

IV. Conclusions.

1. If it is worth the time expended to set up objectives of the educative process, one should select subject matter that will achieve these objectives.

2. Present day texts, such as the ones examined in this study, are apparently written without regard to objectives other than those of a composite nature. This may be necessary from the point of view of the text book writer, as he would hardly care to issue a text usable only in the territory of the North Central Association or of any other standardizing agency.

3. Teachers, or administrators, should select the text that most nearly approximates the objectives they have set up for the course. One should never select the text then set up objectives. The technic illustrated in this study will be found of help in selecting the texts for many subjects.

4. Extreme care is needed to reduce the subjectivity of such studies. It is advised that the investigator evaluate the textbook material at least three times in order to be sure that he is not overly influenced by subjective factors. Wher-

ever possible the opinion of more than one competent investigator will add to the validity of the study.

5. Such devices, as the one illustrated, possess many difficulties and disadvantages. No one would claim that they are exact instruments of measurement. They are, however, an improvevment over the somewhat indefinite and haphazard methods of selecting texts, now used in many cases.

FROM THE SCRAPBOOK OF A TEACHER OF SCIENCE.

By Duane Roller,
The University of Oklahoma, Norman, Okla.

Newton (that proverb of the mind), alas!
Declared, with all his grand discoveries recent,
That he himself felt only "like a youth
Picking up shells by the great ocean—Truth."
—*Byron, "Don Juan."*

The efforts of the great philosopher . . . . were always superhuman; the questions which he did not solve were incapable of solution in his time.—*Arago, of Newton.*

Charles Lamb wrote to a friend, "Coleridge is dead and left 40,000 treatises on metaphysics and divinity, and not one of them complete." That was the failure of one of the rarest geniuses of all time. Learn to finish your work while you are at it.—*Joseph Whitefield Scroggs, "Problems of Personal Development."*

Architecture is frozen music.—*Schelling.*

Science sees signs; poetry, the thing signified.—*J. C. and A. W. Hare.*

There is nothing so much alive and yet so quiet as a woodland.—*R. L. Stevenson.*

Science ever has been, and ever must be, the safeguard of religion.—*Sir David Brewster.*

Our science, so called, is always more barren and mixed with error than our sympathies.—*Thoreau.*

There is not the remotest possibility of deriving the organic from the inorganic.—*J. S. Haldane, "Mechanism, Life and Personality."*

This is the charm from the study of nature herself; she brings us back to absolute truth wherever we wander.—*Louis Agassiz.*

The contemplation of celestial things will make a man both speak and think more sublimely and magnificently when he descends to human affairs.—*Cicero.*

One impulse from a vernal word
May teach you more of man,
Of moral evil and of good,
Than all the sages can.
—*Wordsworth.*

A CONTRACT IN CHEMISTRY: CALCIUM AND ITS COMPOUNDS.

By Ira C. Davis,

University High School, Madison, Wis.

The compounds of calcium are very important commercially. The element itself is too active to be of much value. Calcium is one of the most common elements as far as quantity is concerned.

(The teacher gives a short preview or outline of the contract.)

This contract or unit is based upon:

1. The raw materials containing calcium, where found, how obtained, etc.

2. The chemical actions needed to convert the raw materials into commercial products. This includes the chemical industries and the chemical actions carried on in a commercial manufacturing plant. The by-products obtained are also important.

3. The uses of the products obtained and the necessary chemical information which explains their uses.

The pupil reads the entire contract.

Follow directions carefully. If you are not certain that your answers are correct, consult references freely. Submit experimental work for approval as soon as it is completed. The method used in performing experiments is important. A good chemist is also a good technician. Study the manufacturing processes used.

Fair Contract (6 days)

Textbook, Chapter 28. Brownlee and others, *Chemistry of Common Things,* Chapter 41. Berry, *Chemistry Applied to Home and Community,* pages 116-121.

Perform experiment 84 in manual, parts 1, 2 and 3. *Answer the following questions.* (Use drawings if necessary.)

1. Explain how calcium is obtained from calcium chloride.
2. Describe the physical and chemical properties of calcium. Use equations to represent chemical reactions.
3. In what different forms does calcium carbonate exist? Describe the properties of the different forms. (Use textbook and Chemistry of Common Things as a reference.)

Perform experiment 86. *Write equations for the reactions. Wash and return any unused calcium carbonate.*

4. What makes water "hard"?

5. Write the equation for converting calcium carbonate into the bicarbonate.
6. Write the equation for the heating of calcium bicarbonate.
7. Distinguish between temporary and permanent hard waters.
8. In what two ways may temporary hard water be softened? Write equations to represent the reactions.
9. Why cannot permanent hard water be softened by boiling? Explain fully.
10. How is scale formed in tea kettles or boilers? What effect does this scale have on water boilers and hot water heating plants?
11. What effect does soap have on a hard water? Why are not suds formed immediately? What precipitate is formed when soap is added to hard water? Represent by an equation.
12. Why is it necessary to rinse clothes thoroughly when washed with hard water? What happens if they are not rinsed?
13. Write the equations for the reaction of sodium carbonate with calcium or magnesium sulphate. Why may sodium carbonate be used to soften permanent hard water? Why should this softened hard water be filtered before being used?
14. Practically all of the commercial water softeners precipitate the salts of calcium and magnesium and put salts of sodium in solution. Common salt is used as the softener. Explain how this action softens the water. (Special problem.)
15. Does the softening of hard water make it unfit or undesirable for drinking purposes? Why?
16. How are limestone caves formed?
17. Distinguish between stalagmites and stalactites. How is each formed?
18. What uses are made of calcium carbonate?

(Chemistry applied to Home and Community will be of assistance in answering questions 4 to 18 inclusive.)

The manufacture of lime is an exceedingly important process. It must be comparatively cheap. It must also produce lime which is quite pure. Most of the materials used in constructing buildings at the present time are made artificially, especially in fire-proof buildings.

19. How is limestone converted into lime? Write the equation for the reaction. Why is it necessary to remove the carbon dioxide that is formed? How is this done?
20. What advantage does lime made by the rotary lime kiln have over lime made by other processes?
21. Explain fully how heat economy is secured in the rotary lime kiln. This is an excellent example of modern manufacturing efficiency.
22. Describe the properties and uses of lime.
23. How many pounds of lime may be obtained from one ton of limestone, 98 per cent pure?
24. How is lime slaked? Write an equation for the reaction.
25. What is air-slaked lime? Write two equations to represent the reactions.
26. Starting with lime, explain how limewater could be made.
27. What uses are made of calcium hydroxide?
28. What weight of water enters into combination in slaking 500 pounds of lime, 95 per cent pure?
29. What weight of hydrochloric acid is needed to neutralize 35 grams of calcium hydroxide?
30. Limewater exposed to the air becomes coated with a white film. What is it? Explain its formation.

Perform experiment 99. It will be necessary to collect in advance the paper boxes asked for.

31. How is mortar made?
32. How does mortar harden? Use an equation to represent the reaction.
33. Why do people say that newly plastered houses are apt to be moist or damp?
34. Why does it take such a long time for mortar to harden?
35. The hardening of mortar is hastened in houses being built in cold weather by keeping fires in them. Why does this help?
36. What is the purpose of using sand in mortar? What substances may be substituted for the sand?
37. Will mortar harden under water? Why? Will cement harden under water? Why? How does cement harden?
38. Why is gypsum? What are the different varieties of gypsum?
39. How is gypsum converted into plaster of Paris? Use an equation to represent the reaction.
40. How is a plaster of Paris cast made? How does it harden? Why is it so "tight"?
41. Why is it necessary to convert calcium phosphate into the superphosphate of lime before it can be used as a fertilizer? What necessary element does this fertilizer supply to the soil?
42. What is the formula for bleaching powder? Write the equation for the reaction when chlorine is passed over lime.
43. Write the equation for the reaction when bleaching powder is exposed to moist air.
44. Write the equation for the reaction of hydrochloric acid on bleaching powder.
45. How is a piece of cloth bleached with bleaching powder? Why must the cloth be rinsed thoroughly after it is bleached? (Bleaching may be made a special problem.)

A discussion *in groups* will be held, if necessary, as soon as the work is completed *up to this point*. Get all of the work together and review it thoroughly. Keep in mind the three points upon which this contract is based. Correct any mistakes you have made. If you have had any difficulties, submit them for discussion.

The following questions are given as a summary and as a review of the Fair Contract:

46. Make a table, giving the chemical formula, the chemical name and uses of the following substances: (a) marble, (b) limestone, (c) lime, (d) slaked lime, (e) limewater, (f) calcium bicarbonate, (g) gypsum, (h) plaster of Paris, (i) superphosphate of lime, (j) bleaching powder, (k) chloride of lime, (l) carbide, (m) cyanamid.
47. Write equations for the following chemical reactions: (a) calcium and water; (b) action of carbonic acid on limestone; (c) softening of temporary hard water by heating; (d) softening of temporary hard water by adding slaked lime; (e) heating of limestone; (f) action of water on lime; (g) action of carbon dioxide on limewater; (h) hardening of mortar; (i) converting gypsum into plaster of Paris; (j) hardening of plaster of Paris; (k) action of chlorine on lime; (l) action of hydrochloric acid on bleaching powder; (m) action of chlorine on water; (n) softening of permanent hard water with chemicals; (o) action of soap on hard waters.

Submit the work of the Fair Contract for approval. This

includes the experiments and answers to the questions. Discussions by groups will be held if necessary. As soon as the Fair Contract is approved, prepare for the examination. When you have completed the examination satisfactorily, begin the Good Contract.

Good Contract (6 days including Fair Contract)

References: McPherson and Henderson, *College Chemistry*, Chapter 36. Kahlenberg, *College Chemistry*, Chapter 22. Beery, *Chemistry Applied to Home and Community*, Chapter 3. Baskerville, *Municipal Chemistry*, Chapter 4.

Consult other textbooks in general chemistry and industrial chemistry.

1. Perform Part I of Experiment 88. What method may be used to get one drop of soap at a time? If you do not use city water in your homes, test the water you do use. Make a plan for testing washing powders for the ingredients they contain. This plan should include the tests for the ingredients washing powders usually contain.

Have your method approved before you begin part (2) of experiment 88. Test the washing powder used at home and one standard washing powder. What ingredients did the washing powders contain? (The testing of washing powders may be made a special problem.)

2. How many pounds of lime, 95 per cent pure, may be obtained from 100 kilograms of limestone, 98 per cent pure? What weight of carbon dioxide would be given off during the reaction? What volume would this gas occupy under standard conditions?
3. What methods do cities use to soften hard waters, that is the entire water supply of a city? (May be a special report.)
4. How is plaster of Paris made commercially? (May be a special report.)
5. What uses are made of the following compounds of calcium: (a) Iceland spar, (b) Milk of lime, (c) Calcium sulphite, (d) Calcium sulphide, (e) Calcium fluoride, (f) Calcium chloride.
6. Would it be practical for the city of Madison, or any city, to build a water softening plant? What arguments or facts may be given in favor of it? Against it? Material may be obtained from the Water Superintendent. (This may be used as a special problem.)

Excellent Contract (6 days including fair and good contracts)

Use the reference books given in the Good Contract.

1. How much sulphuric acid (95 per cent pure) is needed to convert 8 grams of calcium phosphate into superphosphate of lime? Mix the two substances in the correct proportions and stir thoroughly. *Devise a method for testing the solubility of the superphosphate of lime formed.* Test the substance for its solubility. What per cent of it is soluble? (The manufacture of phosphate fertilizers may be made a special problem.)
2. Show experimentally how plaster of Paris is used to secure the exact reproduction of some small object. Then make the reproduction. (Special problem.)
3. What are plasters? How are they made? How do they differ from mortar? (Consult building contractors.) (Special problem.)

4. What is stucco? How is stucco placed on a building? (Consult building contractors.) (Special problem.)

5. The average family uses 25 tons, or over, of water in a year, one tenth of which is used with soap. If the water is hard and contains .01 per cent calcium sulphate, what is the approximate value of the soap used each year to soften the water, supposing the soap to be sodium stearate? A 5 cent cake of soap weighs about 10 ounces and often contains 40 per cent water.

6. Phosphate rock is worth $6 per ton; superphosphate of lime is worth $25 per ton; waste sulphuric acid from oil refineries may be purchased for $6 a ton. If the cost of labor is 25 per cent of the cost of materials, how much profit is made in manufacturing one ton of the superphosphate of lime?

7. Methods used by laundries to wash clothing.

Pupils completing the *G* and *E* contracts should have the material in form to present to the class for discussion. (A class discussion will be held upon the completion of the contracts.) This is your opportunity to clear up points not well understood. (3 to 4 days discussion including reports.)

A mastery test is usually given at the completion of the discussion. The test includes material in the fair, good and excellent contracts.

PACIFIC OCEAN HAS LESS OXYGEN THAN ATLANTIC.

There is less oxygen in the water of the Pacific Ocean than there is in Atlantic Ocean water. There is more oxygen in the water of great deeps of both oceans than there is in water from moderate depths.

These are among the discoveries made by Dr. Erik G. Moberg of the Scripps Institution of Oceanography, after a chemical study of thousands of samples of ocean water. Since all plant and animal life in the ocean is dependent on oxygen no less than is life on land, such studies as Dr. Moberg's are of fundamental practical as well as theoretical importance.

Dr. Moberg found the greatest oxygen content in Pacific Ocean water at the surface. Here the water was nearly saturated with oxygen. The content fell off in samples taken from increasing depths, until at about 2000 feet there was less than one part of oxygen per thousand of water.

From this depth onwards the oxygen content increased again, reaching its highest point at the bottom. The highest deep-water oxygen ratio found was 3.45 parts per thousand of water.—*Science Service.*

DEATH TAKES TWO WELL-KNOWN PUBLISHERS.

William Edmond Pulsifer, President of D. C. Heath and Company for seventeen years, from 1910 to 1927, died January 4, 1931.

George A. Helms, who for the past eight years has been Manager of the High School and College Department of the John C. Winston Company, died January 5, 1931.

Both of these men were very capable business leaders and were well-known in educational circles.

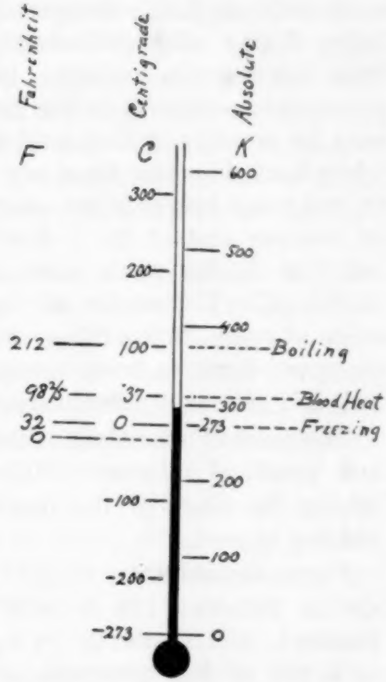
BACKGROUND AND FOREGROUND OF GENERAL SCIENCE.

No. XVI. Heat and Cold.

By Wm. T. Skilling,

State Teachers' College, San Diego, Calif.

In any discussion of cold there should be in the background of our thought the realization that cold, however intense, is but some certain degree of heat. Heat corresponds very closely to the kinetic energy of a moving body. Kinetic energy comes to zero only when the body comes to rest. For all practical purposes we can consider that molecules never come to rest and therefore heat, which is atomic motion is a property of matter which virtually never leaves it.



Many of us have seen the standard liquid air demonstration of a teakettle of the liquid boiling violently on a block of ice. Of course the heat to cause boiling came out of the block of ice. Removed from the ice boiling stops, or slows down, due to inability of the kettle to secure a sufficient quantity of heat through the nonconducting air.

A simpler test to show that ice still has some warmth is to compare it with a well stirred mixture of crushed ice and salt, or better ice and ammonium chloride. A thermometer removed from the mixture and placed in clean crushed ice rises many degrees, showing that its mercury takes heat from the ice.

A diagram of a thermometer showing temperatures on the absolute scale as shown in the accompanying cut helps to impress the right conception of different degrees of temperature. It will be better understood if the Centigrade and Fahrenheit scales are shown on the same thermometer,

and likewise some of the well known points of temperature as freezing point, blood heat, etc.

When the subject of temperature is up for discussion a few specific facts in regard to certain interesting points along the scale will add definiteness to the subject. There is at least as much danger of the general science course being sloppy with glittering generalities as in being dry from too many bare facts. In addition to the special temperatures mentioned in the diagram of the thermometer it may be mentioned that lead melts at 327° C. The Moon, when dark, is colder than any place on earth, about —150° C., but when bright is hot enough to boil water. The surface of the sun and of the yellow stars is at about 6000° C., but that of the white stars is as high in some cases as 20,000° C. The center of the sun and stars is estimated to be at some forty million degrees. There is theoretically no upper limit to temperature, but there is a lower limit (at -273° C., or 0° absolute scale).

The subject of refrigeration is one of both theoretical and practical interest. Since so many refrigerators are taking the place of the family ice chest illustrations are not far to seek.

Pupils should learn the principles of refrigeration which are as follows: (1) A solid (ice) changing to a liquid (water), and then (2) to a gas (steam) and then, (3) to a gas of less pressure, all these changes absorb heat from the surrounding and thus *cool* whatever is near.

The reverse series of changes in a substance produces *heat*. Thus (1) a rare gas to a compressed one, (2) gas to liquid, (3) liquid to solid, are changes that give out heat—just as much as the other series took in from the surroundings. In order to use the same material over and over again in a refrigerator it must go through both the heating and cooling series (in part at least). The heat would just balance the cold, but it is carried away as fast as it is generated by running water, or blown away by a fan. In some refrigerators the substance changed from one form to another is carbon dioxide, in some it is ammonia, and in others it is ethyl chloride. It must be something that evaporates easily from liquid to gaseous form.

The cooling effect of such rapidly evaporating liquids as ether or gasoline may be shown by putting a little on the skin and fanning it.

A more striking test is to put some ether in a watch glass, set the glass on a cork which has two or three drops of water on it. Blow with a syringe bulb on the ether and the glass will become frozen to the cork.

A new refrigerant is now coming into use for such purposes as keeping ice cream from melting. It is called "dry ice" and is made of solid carbon dioxide. Instead of melting to a liquid the solid evaporates directly to a gas (sublimes) and in doing so keeps its temperature at 112° below zero, Fahrenheit.

Dry ice is made in cubical blocks ten inches in each direction. The blocks weigh forty pounds. It should be handled with care to avoid "burns." It should not come in contact with the skin except for an instant. Since it is almost as many degrees colder than the ordinary things we touch as boiling water is hotter than these ordinary things its effect is somewhat the same.

A demonstration of the freezing of mercury can be very simply done with a small piece of dry ice secured from an ice cream factory. With a medicine dropper put drops of mercury in little depressions in the dry ice. They quickly freeze and become hard like shot. The freezing point of mercury is about 39° below zero—about the same on either the Fahrenheit or Centigrade scale.

Pupils of a general science class are old enough to distinguish between heat quantity and temperature—between calories and degrees. They may easily understand that the amount of heat in a body depends upon its weight, its temperature, and the material of which it is made. The first two ideas are self evident; the third can be proved as follows to be true.

Boil a little water with an equal weight of pebbles or some such thing. Quickly drain off the hot water into a dish of cold water, and pour the pebbles into an equal dish of cold water. The resulting temperatures are so markedly different that it is easy to see that water gives more heat than an equal weight of something else at the same temperature.

The word "calories" is in such common use, often with very little comprehension as to its meaning, that it is worth while to demonstrate the meaning of calorie. For the large calorie, which is the one used in dietetics, this is easily done by warming a liter (1000 grams) of water one centigrade degree. An idea is thus acquired as to the value of a calorie. The length of time the water must be over the fire gives a very good mental picture of the amount of heat in a calorie. The food needed by a man in one day is capable of developing in his body about 3000 of these calories, or their equivalent in energy. If the food were burned and none of the heat lost it would warm 3000 liters of water one degree or half that much two degrees, and so on.

With some simplification of terminology by the omission of a few perfectly useless words the subject of transfer of heat can be profitably dealt with in the general science class. The three natural ways by which heat travels from one place to another without artificial assistance are by shining, by currents, and by conduction.

A few illustrations of each of these methods cannot help but make them clear. The pupils already know that heat as well as light shines upon us from the sun. To show that heat shines out from a non-luminous body hold the palm of the hand as close as possible to the forehead or cheek. Warmth is felt. Hold the hand under or beside a hot flatiron. Notice the much greater amount of heat coming to the hand held above the iron due to both shining and air currents bearing heat.

A striking demonstration of heat carried by air currents is made by setting a hot flatiron on the sill of a window through which the sun is shining in onto the floor. A flow of lights and shadows along the floor shows that air is rising from the iron, though the rising column of air itself is invisible.

To realize the meaning of conductivity and the different degrees of conductivity hold several objects of approximately equal size but of different material in the flame of an alcohol lamp or a candle. Use such materials as glass, wood, iron, copper, silver, etc. Notice that a silver coin has to be dropped much sooner than an iron washer.

FOUR UNITS TO ILLUSTRATE MOTIVATION IN THE TEACHING OF GEOGRAPHY: PART III.

By ALICE J. HAHN,

Proviso High School, Maywood, Ill.

In the last issue of the Journal we discussed part 5 under unit IV on the Study of Oceans, taking up *Oceans as Carriers of Commerce.* We shall now pass on to the discussion of Inland Water Bodies, and take up, under part 1, the study of *Inland Bodies of Water as Barriers.* After having discussed with the children the first two points listed, we study the third point more thoroughly, i. e. how inland water barriers help to determine the location of cities. We find that inland cities tend to grow up: (a) *At a ford or ferry on a river* where important land routes meet; (b) *At falls or rapids* where river or lake freight must be unloaded, carried around the obstruction, and either reloaded or forwarded, by land; (c) *At junction of large rivers* where traffic coming up-stream is divided, a part going up each stream, and where in many cases commodities coming down the tributary streams are transferred to boats operating on the main river; (d) *At outside of great bends* in a river, thus making a greater percentage of the surrounding area accessible to the river market without making it necessary to cross the river itself; (e) *At the tip of large lakes* which form a barrier to important trade routes so that railroads must bend around them; (f) *At bulk-breaking points on lakes,* where goods must be transferred from lake to river boats or from boats to railroads and vice versa. In many cases the immediate location of the city was chosen because of a natural line of communication leading from the shore of the lake, such as a river or a valley; (g) *At portages,* where in the olden days it was only a short land haul from one body of water to another, making it possible for the Indians to carry their canoes across. These later often became places of strategic importance, because important trade routes could be controlled by only one fort; and (h) *At the head of river navigation* for large boats where goods must be transferred to smaller boats or from water to land and vice versa.

After the children thoroughly understand these principles, they are again given a list of cities, which you will

find near the end of the division, to locate and classify. Some of the cities will be tabulated under several of the headings, which tabulation will help to explain their relative importance. Thus, Chicago might be classified under e, f, and g, being at the tip of Lake Michigan, where many railroads must bend around the lake, at a bulk-breaking point where goods must be transferred from lake to river boats or from boats to railroads and vice versa, and at a former portage between the Chicago and the Des Plaines Rivers, which controls an important trade route leading on to the Mississippi. These are, of course, not the only reasons for Chicago's importance and growth. Some of the others will have been studied in connection with the units on land-forms, climate, etc. In studying Chicago here, in order to bring out more clearly the effectiveness of Lake Michigan as a water barrier, the children are asked to work out the problem listed here at the end of the division. That is, they are asked to draw lines to connect the given cities by the shortest route that it is possible for railroads to follow. Often, to their surprise, they find that these lines intercept at Chicago, which, of course, helps to explain why Chicago has become the greatest railroad center in the world.

Unit IV.

Water Bodies: Their effects upon Human Activities.

II. Part 1. Inland Bodies of Water as Barriers.

References:

1. Geog. (Physical-Economic-Regional) Chamberlain pp. 132.
2. College Geog. (Peattie) pp. 285-296.
3. New Phys. Geog. (Tarr and von Engeln) pp. 586-587.
4. Principles of Human Geog. (Huntington & Cushing) pp. 129-133.
5. Intro. to Econ. Geog. (Jones and Whittlesey) pp. 316-317.
6. Business Geog. (Huntington and Cushing) pp. 318-319.
7. H. S. Geog. (Dryer) pp. 386-390; 415-418.
8. Modern Geog. (Salisbury, Barrows, and Tower) pp. 401-403.

A. Important points to be discussed in class.
   1. Why inland bodies of water are barriers.
      a. Rivers
         (1) Smallness
         (2) Great number
      b. Lakes
   2. How the barrier effect of inland bodies of water differs from that of the oceans.
   3. How inland water barriers help determine the locations of cities.
      a. *At a ford or ferry* on a river where important land routes meet.
      b. *At falls or rapids* where river or lake freight must be unloaded, carried around the obstruction, and either reloaded or forwarded by land.

c. *At junction of large rivers* where traffic coming upstream is divided, a part going up each stream, and where in many cases commodities coming down the tributary streams are transferred to boats operating on the main river.

d. *At outside of great bends* in a river, thus making a greater percentage of the surrounding area accessible to the river market without making it necessary to cross the river itself.

e. *At the tip of large lakes* which form a barrier to important trade routes so that railroads must bend around them.

f. *At bulk-breaking points on lakes,* where goods must be transferred from lake to river boats or from boats to railroads and vice versa. In many cases the immediate location was chosen because it was at a natural line of communication leading from the shore of the lake, such as a river or a valley.

g. *At portages,* where in the olden days it was only a short land haul from one body of water to another, making it possible for the Indians to carry their canoes across. These later often became places of strategic importance, because important trade routes could be controlled by only one fort.

h. *At the head of river navigation* for large boats where goods must be transferred to smaller boats or from water to land and vice versa.

4. Classify the following cities according to (a), (b), (c), (d), (e), (f), (g) or (h) above. Some may be classified under more than one. Locate them on a base map of the world.

Cities.

1.	Pittsburgh, Penn.	21.	Hankow, China
2.	Chicago, Illinois	22.	London, England
3.	Cincinnati, O.	23.	Rochester, N. Y.
4.	St. Louis, Mo.	24.	Niagara Falls, N. Y.
5.	Louisville, Ky.	25.	Buffalo, N. Y.
6.	St. Paul-Minneapolis, Minn.	26.	Lowell, Mass.
7.	Manaos, Brazil	27.	Rosario, Argentina
8.	Cairo, Egypt	28.	Holyoke, Mass.
9.	Winnipeg, Canada	29.	Portage, Wis.
10.	Aswan (Assuan), Egypt	30.	Superior, Wis.
11.	Timbuctu, French Sudan	31.	Ft. Wayne, Ind.
12.	Ichang, China	32.	Erie, Penn.
13.	Belgrade, Yugoslavia	33.	North Bay, Ontario
14.	Nizhni-Novgorod, Russia	34.	Detroit, Mich.
15.	Frankfort-on-Main, Germany	35.	Milwaukee, Wis.
16.	Paris, France	36.	Duluth, Minn.
17.	Spokane, Wash.	37.	Toledo, O.
18.	Kansas City, Mo.	38.	Cleveland, O.
19.	Vienna, Austria	39.	Sault Ste. Marie, Mich.
20.	Stanleyville, Belgian Congo	40.	Toronto, Canada (Ontario)

5. Study: The Miss. River as a water barrier.
   a. Its use as a political boundary in U. S. History.
   b. The few Bridges, and delays resulting therefrom.

6. Study: Lake Michigan as a water barrier.
   On a base map draw lines to connect the following cities by the shortest possible route that might be followed by railroads. What city is located where they intercept? Why *must* they intercept here?

Cities.

1.	Bismarck, N. D.	Detroit, Mich.
2.	Omaha, Neb.	Toledo, O.
3.	Spokane, Wash.	Buffalo, N. Y.
4.	Milwaukee, Wis.	Ann Arbor, Mich.
5.	Boston, Mass.	Minneapolis, Minn.
6.	N. Y. City, N. Y.	Duluth, Minn.
7.	Denver, Colo.	Toronto, Canada
8.	Washington, D. C.	St. Paul, Minn.

CONVECTION.

By HOMER W. LESOURD,
Milton Academy, Milton, Mass.

"When air over a hot surface is heated, this air expands and rises. Its place is taken by cooler air." This explanation for convection has now been replaced in practically all textbooks by the more satisfactory one of the denser fluid lifting the one that is less dense.

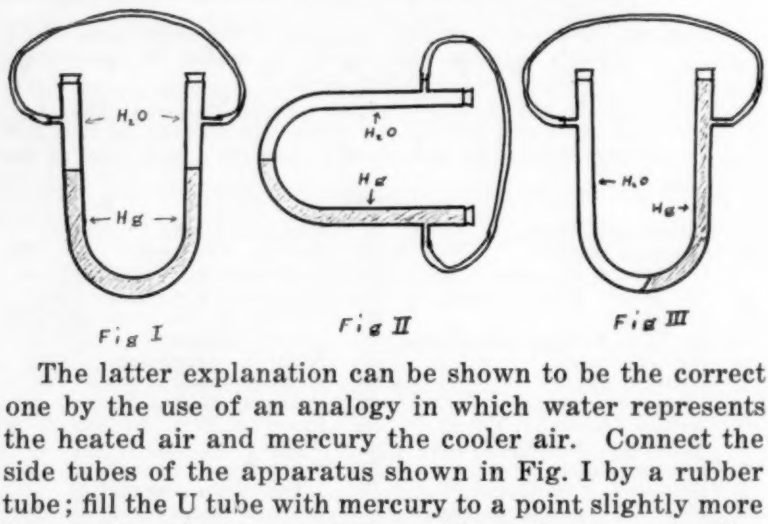


Fig I Fig II Fig III

The latter explanation can be shown to be the correct one by the use of an analogy in which water represents the heated air and mercury the cooler air. Connect the side tubes of the apparatus shown in Fig. I by a rubber tube; fill the U tube with mercury to a point slightly more than half and the remainder with water on each side. Close the U tube with two corks and tip the tube to the position shown in Fig. II. Pinch the rubber tube and restore the tube to the upright position as in Fig. III. If the pinchcock is now opened the liquids will return to their original position. Why the motion in this direction? Certainly no one explains this by stating that "the water rises and its place is taken by mercury." Here, as in convection phenomena, the denser fluid runs under and lifts the lighter one.

BASES OF INSTRUCTION IN ELEMENTARY ALGEBRA.

By LEONARD D. HAERTTER,
John Burroughs School, Clayton, Mo.

One of the most important tasks that confronts the teacher of elementary algebra is that of determining the proper place at which to begin instruction. The customary procedure is to start work by having all pupils study the material presented on the first page of the text book. Practically no effort is made to determine what portions of the materials already studied have been retained by the pupil, or what portions of the topic about to be considered are already familiar to him.

This method of instruction has no regard for the fact that ninth grade pupils have varying degrees of understanding of a common body of knowledge usually taught in the eighth grade, and that many pupils have a knowledge of certain topics usually treated at the beginning of an elementary algebra course. If we believe that it is desirable to build upon the past experiences of the pupil, then it is necessary to use some device which will aid us in determining what these experiences have been and which of them can be built upon.

An inventory test is a method admirably fitted for this purpose. It can be used to advantage in examining a pupil on content requisite to the successful completion of a given unit of work, and in examining a pupil on the content of a unit of work about to be undertaken in order to learn at what point in that unit instruction should properly begin.

The customary topics with which the study of elementary algebra is begun assume that the pupil has a thorough knowledge of the fundamental operations with integers, fractions, and decimals. Unfortunately, this assumption is not usually justified. The fact that pupils forget processes once understood, and that certain pupils never did master some of these processes, brings many pupils to the beginning of the ninth school year inadequately grounded in the necessary arithmetic skills. Teachers too frequently are little concerned with this situation. The pupil with weaknesses is rebuked for not being familiar with the material presented in the eighth grade, and is told that marked improvement must be made if the

study of the subject is to be successfully continued.

The inventory test offers an excellent method for improving the situation. Let us assume, for example, that equations of the type $ax=b$, $x/a=b$, $x-a=b$, and $x+a=b$, are to be studied, and that the pupil possesses the necessary abilities with integers and decimals. Since a knowledge of the fundamental operations with fractions is essential to the solving and checking of such equations, abilities with fractions such as are included in the following test should be had by each pupil on beginning work on this topic.

Inventory Test—Fractions.

Addition.

Add as indicated:

1. $\frac{1}{3}+3=$	4. $\frac{2}{3}+\frac{3}{4}=$	7. $1\frac{1}{8}+2\frac{1}{3}=$
2. $8+\frac{3}{4}=$	5. $4\frac{2}{3}+6=$	8. $1\frac{1}{2}+3\frac{3}{4}=$
3. $\frac{1}{4}+\frac{1}{4}=$	6. $12+6\frac{1}{2}=$	9. $2\frac{5}{8}+3\frac{1}{5}=$

Subtraction.

Subtract as indicated:

1. $5-\frac{1}{3}=$	5. $\frac{7}{3}-2=$
2. $8-1\frac{2}{3}=$	6. $8\frac{1}{5}-5=$
3. $\frac{5}{6}-\frac{1}{6}=$	7. $9\frac{1}{2}-2\frac{1}{4}=$
4. $\frac{2}{3}-\frac{1}{4}=$	8. $6\frac{2}{5}-3\frac{3}{5}=$

Multiplication.

Multiply as indicated:

1. $12\text{x}\frac{1}{2}=$	5. $1\frac{1}{3}\text{x}24=$	9. $\frac{3}{8}\text{x}\frac{5}{9}=$
2. $16\text{x}\frac{3}{4}=$	6. $2\frac{5}{6}\text{x}11=$	10. $\frac{3}{4}\text{x}1\frac{3}{5}=$
3. $\frac{1}{3}\text{x}10=$	7. $\frac{5}{6}\text{x}\frac{6}{5}=$	11. $4\frac{1}{2}\text{x}2\frac{2}{3}=$
4. $\frac{3}{4}\text{x}15=$	8. $\frac{7}{8}\text{x}\frac{4}{7}=$	12. $5\frac{1}{2}\text{x}1\frac{2}{3}=$

Division.

Divide as indicated:

1. $24\div\frac{1}{3}=$	7. $2\frac{2}{3}\div 8=$
2. $16\div\frac{4}{5}=$	8. $3\frac{1}{2}\div 4=$
3. $12\div 1\frac{1}{5}=$	9. $\frac{3}{4}\div 7\frac{1}{2}=$
4. $8\div 4\frac{1}{3}=$	10. $\frac{5}{8}\div\frac{3}{4}=$
5. $\frac{1}{2}\div 6=$	11. $3\frac{3}{4}\div 7\frac{1}{2}=$
6. $\frac{3}{5}\div 9=$	12. $2\frac{1}{2}\div 6\frac{1}{3}=$

When during the study of this topic shall these tests be taken? Shall the teacher wait until certain weaknesses appear and then administer the tests? This procedure is better than not to give the tests at all. It has, however, the disadvantage of interrupting the development of the unit, and making the new work seem difficult when in reality the arithmetic weaknesses are solely to blame. A more effective procedure is to arrange an inventory test to precede immediately those portions of a topic wherein these particular arithmetic abilities are first required. If this happens to be in a study of the formula, the test should be given then; if in the treatment of the simple equation, it

should be given then. By so doing, we know exactly upon what basis we are building and can provide adequate instruction to furnish the knowledge necessary to a successful and enjoyable study of the topic.

It is necessary to make the proper use of such tests after they have been given. The results of the tests should be carefully studied to determine the exact difficulty of each pupil. The errors that appear should be variously classified. Some pupils may have a total lack of knowledge of the operations with fractions, some may have special weaknesses in one or more of the four processes, while yet others may need instruction in form of work, and so on. The weakness, once diagnosed, should be corrected by the teacher through remedial instruction, and by the use of drill material. The pupil with no weaknesses, obviously, need spend no time in the practice of working problems of the type contained in the test. Such pupils should spend their time working on extra projects, or in aiding the teacher in removing the weaknesses of other pupils.

Inventory tests on the various fundamental operations with integers, fractions, and decimals, should be prepared by the teacher and carefully filed, so that they are immediately available when needed. Such tests can be revised from year to year until they are entirely satisfactory for the individual teacher.

A second, and the more important role of the inventory test is its use in determining the most appropriate place at which to begin the study of elementary algebra. In recent years much of the work with the formula and the simple equation has been introduced into the eighth school year. In the years to come these topics will be even more extensively treated in this grade. Shall teachers take consideration of this fact when teaching pupils who are beginning the study of elementary algebra in the ninth school year? If the reorganization of the mathematics content in the Junior High School and the instruction in these grades is to be really effective, then we must build on the pupil's experience, rather than spend several weeks on material with which he is already familiar.

Many texts in elementary algebra begin work with the study of the formula. Since the pupils have had consider-

able instruction on this topic in the eighth grade, the teacher should prepare an inventory test covering the abilities deemed of fundamental importance in a study of the formula and a knowledge of which is necessary before the next succeeding topic can be studied. The following test is an inventory of the abilities to be established in studying the formula.

INVENTORY TEST—THE FORMULA.

Write a formula for each of the following rules:

1. The perimeter of a rectangle is equal to twice the length plus twice the width.
2. The area of a square is equal to the square of its side.
3. Pi is equal to the quotient of the circumference of a circle by its diameter.
4. The amount is equal to the principal plus the interest.
5. The area of a trapezoid is equal to half the sum of the bases times the height.
6. The volume of a circular cylinder is equal to pi times the square of the radius times the height.

In each of the following formulas find the value of the letter indicated:

7. In the formula, $A = \frac{1}{2}bh$, find the value of A if $b = 48$ feet, and $h = 24$ feet.
8. In the formula, $A = p + prt$, find the value of A if $p = \$300$, $r = .05$, and $t = 4$ years.

State as a rule each of the following formulas:

9. $A = bh$	11. $S = 6e^2$	13. $C = 2\pi r$
10. $i = prt$	12. $A = bh/2$	14. $A = p + i$

What measurements is it necessary to make to find:

15. The area of a circle?	17. The area of a triangle?
16. The surface of a cube?	18. The volume of a cylinder?

19. What is the cost of covering the floor of a rectangular hall 125 feet long and 9 feet wide with linoleum tiles, if the tiles cost 40 cents a square foot?
20. The diameter of the base of a silo in the shape of a circular cylinder is 15 feet and its height 32 feet. If the silo is full of ensilage, what is its value at 28 cents a cubic yard?

When such a test is given to a class about to study the formula, the results obtained will usually show a variety of facts. Some portions of this work will be thoroughly familiar to every member of the class. This fact should indicate that very little or no class time should be spent in reteaching such work. A review of such facts will be provided in subsequent work of the text if the text has been properly organized.

Other portions of the work will be familiar to some pupils and not at all familiar to others. What shall be the procedure in such cases? Shall everyone be required to study this work again? There are some teachers who contend that all members of the class should repeat this work, those pupils with no weaknesses profiting by the review it affords. What such a procedure really amounts to is a marking of

time for many students, a deadening of interest, and in many cases an annoyance to pupils for being compelled to do tasks which they understand and can do. Teachers who require all members of a class to do a piece of work with which certain pupils are thoroughly familiar, do so in my judgment because they have no effective classroom procedure to meet a situation such as this. In such instances, pupils who understand the process in question should devote their time to aiding the teacher in removing the weaknesses of other pupils, to pursuing some mathematical interest beyond the requirements of the course, or to investigating some portion of the history of mathematics. These and other activities that will occur to the teacher will arouse and hold the interest of the pupil and challenge his thinking.

The tests will finally show that some portions of a given topic must be taught to all members of the class. Due emphasis should be given to such work, and adequate instruction provided. Pupil interest will usually be present because the pupils are confronted with something new and challenging, and with material that will require them to use their best efforts.

The inventory test as here described furnishes an excellent basis of instruction with two important uses. The first use provides a means of determining definitely what portions of work previously studied and requisite to a satisfactory study of a topic about to be considered, form a part of the pupil's present knowledge. The second use is that of ascertaining what portions of a new topic about to be considered already form a part of the pupil's information.

Such devices save time and effort for both pupil and teacher. They offer a means of making our instruction more effective and the learning of the pupil more thorough. It also makes teaching, not a catch-as-catch-can process, but a scientific procedure.

A second necessary device for effective learning by the pupil and instruction by the teacher, enables the pupil to check his understanding of the work of a topic at various points in its development, and the teacher to measure the effectiveness of his instruction. This device is spoken of here as the *instructional test*.

In order to be really effective such tests should be constructed to examine the pupil on all the abilities which a

particular topic is intended to develop. This will mean, as a rule, several tests each consisting of a large number of specific items. The following is a set of instructional tests for teaching the simple equation. These tests would be followed at the close of the study of the topic by a test consisting of equations which involve combinations of the types here given.

INSTRUCTIONAL TESTS—THE SIMPLE EQUATION

Test 1

Solve each of the following equations for the letter indicated:

1.	$3x=3$	11.	$1.2x=.48$
	$x=$		$x=$
2.	$2x=0$	12.	$7=3t$
	$x=$		$=t$
3.	$3m=5$	13.	$8x=1$
	$m=$		$x=$
4.	$3r=1.2$	14.	$2c=\frac{2}{3}$
	$r=$		$c=$
5.	$.5r=10$	15.	$3y=\frac{2}{5}$
	$r=$		$y=$
6.	$.4x=2.8$	16.	$5b=1\frac{3}{7}$
	$x=$		$b=$
7.	$132=22x$	17.	$A=lw$
	$=x$		$=l$
8.	$0=5a$	18.	$C=\pi d$
	$=a$		$=\pi$
9.	$7x=3$	19.	$ns=p$
	$x=$		$s=$
10.	$21=7s$	20.	$d=rt$
	$=s$		$=t$

Test 2

Solve each of the following equations for the letter indicated:

1.	$x/3=2$	11.	$7=n/1.5$
	$x=$		$=n$
2.	$n/5=0$	12.	$4.8=x/2.5$
	$n=$		$=x$
3.	$\frac{1}{3}n=3$	13.	$x/2=\frac{3}{2}$
	$n=$		$x=$
4.	$\frac{1}{4}y=0$	14.	$\frac{1}{4}n=\frac{5}{8}$
	$y=$		$n=$
5.	$r/2=1.2$	15.	$\frac{5}{6}=\frac{1}{6}y$
	$r=$		$=y$
6.	$x/.2=8$	16.	$\frac{7}{8}=\frac{3}{4}t$
	$x=$		$=t$
7.	$\frac{1}{4}r=5$	17.	$A/w=l$
	$r=$		$A=$
8.	$n/.3=1.2$	18.	$d/r=t$
	$n=$		$d=$
9.	$12=s/5$	19.	$A=bh/2$
	$=s$		$=b$
10.	$0=x/8$	20.	$C/\pi=d$
	$=x$		$C=$

Test 3

Solve each of the following equations for the letter indicated:

1.	$x+4=4$	3.	$y+25=73$
	$x=$		$y=$
2.	$15=8+n$	4.	$82=43+x$
	$=n$		$=x$

5.	$y+1.5=3$ $y=$	13.	$t+4=5\frac{1}{2}$ $t=$
6.	$19=x+8.2$ $=x$	14.	$8=3\frac{3}{8}+y$ $=y$
7.	$y+.5=1.8$ $y=$	15.	$r+2\frac{1}{3}=3\frac{3}{4}$ $r=$
8.	$5.4=x+4$ $=x$	16.	$5\frac{1}{6}=2\frac{1}{2}+y$ $=y$
9.	$y+5\frac{1}{2}=25$ $y=$	17.	$i+p=\mathrm{A}$ $p=$
10.	$16=x+7\frac{1}{2}$ $=x$	18.	$\mathrm{C}+\mathrm{G}=\mathrm{S}$ $\mathrm{G}=$
11.	$r+\frac{1}{3}=\frac{3}{4}$ $r=$	19.	$x+y=6$ $x=$
12.	$n+\frac{1}{3}=2\frac{1}{2}$ $n=$	20.	$y=ax+b$ $=b$

Test 4

Solve each of the following equations for the letter indicated:

1.	$n-3=5$ $n=$	11.	$4=y-1.8$ $=y$
2.	$y-8=0$ $y=$	12.	$.48=n-6.8$ $=n$
3.	$4=x-1$ $=x$	13.	$n-\frac{1}{2}=2\frac{1}{2}$ $n=$
4.	$27=y-36$ $=y$	14.	$m-\frac{1}{3}=6\frac{1}{2}$ $m=$
5.	$y-38=59$ $y=$	15.	$19\frac{3}{5}=x-2\frac{1}{2}$ $=x$
6.	$0=n-1$ $=n$	16.	$t-8\frac{1}{3}=4\frac{2}{3}$ $t=$
7.	$x-\frac{1}{3}=0$ $x=$	17.	$\mathrm{L}=\mathrm{C}-\mathrm{S}$ $=\mathrm{C}$
8.	$x-\frac{3}{4}=\frac{3}{5}$ $x=$	18.	$\mathrm{S}-\mathrm{C}=p$ $\mathrm{S}=$
9.	$n-2.3=4$ $n=$	19.	$\mathrm{A}-i=p$ $\mathrm{A}=$
10.	$x-25.6=82$ $x=$	20.	$\mathrm{P}-2l=2w$ $P=$

In order to be most effective, such tests should be administered by the teacher at various stages in the development of a topic. Such a process will not allow weaknesses to continue beyond the point when it is most expedient and economical of time and effort to remove them. Unless pupil difficulties are detected in this manner they are often the cause of difficulty in the latter part of the topic. A series of minor weaknesses allowed to accumulate until the end of a topic or chapter, frequently result in the pupil repeating the unit or receiving a low or failing grade. If, however, the instructional tests are given at various points in the study of a topic, the sources of difficulty are removed with little effort, wrong practice in the process is reduced to a minimum, and a satisfactory basis is established for a study of the next part of the work. The pupil has a check on

how effective his learning has been, and the teacher, of his method of teaching.

Ample time should be given each pupil to work all the exercises of each test, for only in this way is it possible to determine whether or not the fundamental abilities involved have been mastered. The student who is exceptionally slow should be noted, and an effort made later to increase his facility. The prime purpose of such tests is the aid they are to both pupil and teacher for more effective learning by the pupil.

When the pupils of a class have completed such a test, it should be carefully checked to reveal any errors. This can be done by having the teacher read the answers while the pupils score the papers. The papers with errors should then be carefully studied by pupil and teacher. In some cases errors will be due to carelessness. In such instances the pupil should be shown that his carelessness is due to haste, poor penmanship, the omission of certain intermediate steps, and so on. His future work should be carefully noted to see that he has profited by the suggestions made. In other cases, the teacher will find that the process never was thoroughly learned. Additional explanation and drill material must be provided for such pupils. After adequate explanation has been given, the pupil should be referred to review material given in the text or prepared on cards. When this has been done, the same or a similar instructional test should be given. If the remedial instruction has been satisfactorily done, this second testing will in the majority of cases be sufficient.

Pupils for whom the instructional tests reveal no weaknesses continue with the work of the topic or work on some extra project while the difficulties of other pupils are being removed. Because of this procedure it is the goal of more and more pupils to achieve mastery on each of the instructional tests. This soon produces an interest which rapidly carries the pupil forward in his year's work. His progress is interesting because it is successful.

Instructional tests if used as outlined in this article form a second important basis for improving classroom instruction. If thus employed they become a means to an end and not an end in themselves. That end is the promotion of the

learning on the part of the pupil and not a means of determining his grades.

The following articles will be found helpful in a further study of the points discussed here:

AUSTIN, C. M. "An Experiment in Testing and Classifying Pupils in Beginning Algebra." Mathematics Teacher, Jan., 1924.

BRESLICH, E. R. "Testing as a Means of Improving the Teaching of High School Mathematics." Mathematics Teacher, May, 1921.

DEAN, T. M. "Diagnostic Algebra Tests and Remedial Measures." School Review, May, 1923.

HAERTTER, L. D. "Use of the Inventory Test in Plane Geometry." Mathematics Teacher, March, 1926.

PARSONS, A. R. and YEOMANS, R. "How Diagnostic and Inventory Tests Help in Securing 100 per cent accuracy in Computational Arithmetic." American Education, May, 1927.

SCIENTISTS TO PROBE BASE OF INDIAN MOUND AT CAHOKIA.

Relics of prehistoric America buried at the base of the Powell Mound, one of the great Cahokia group of Indian mounds, are to be sought by Dr. A. R. Kelly, director of Illinois archaeological explorations.

Scientific interest in the mound was aroused when steam shovel operations were about to level it for farming purposes. The upper layers, now removed, contained many objects belonging to the mound-building Indians of the Cahokia settlement.

The basal portion of the mound will shed new light on the rather mysterious Cahokia mound builders, it is hoped. Cahokia was an exceptionally large settlement of Indians, yet not particularly progressive, judging by its art and crafts. The present theory is that the settlement acquired its culture from farther south. That the culture may have extended as far north as Wisconsin is indicated by objects found at the Aztalan ruins in Wisconsin.

A party from the Milwaukee Public Museum, led by Dr. S. A. Barrett, the director, has examined the Powell Mound site and considers that the objects already found there offer new evidence of a link between the Cahokia settlement and the Aztalan mound builders.—*Science Service.*

LIVER EXTRACT AID IN TREATING PELLAGRA.

Liver extract is a fairly good source of the anti-pellagric vitamin G and consequently would be of value in large quantities in the treatment of pellagra, the U. S. Public Health Service has reported. This finding was the result of investigations on dogs who suffer from a disease similar to pellagra in humans.

The study was begun under the direction of Dr. Joseph Goldberger before his death and was carried out by Dr. W. H. Sebrell of the Public Health Service. The liver extract used was developed by Dr. George R. Minot of Harvard University, who with Dr. George H. Whipple of the University of Rochester, recently was awarded a $10,000 prize for their achievement in the solution of the problems of simple and pernicious anemia.—*Science Service.*

SCIENCE CLUBS FOR SERVICE.

By KARL F. OERLEIN,
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From time to time there have appeared in this journal articles on club activities and more particularly science clubs. Hence, it would not be surprising for the reader to ask, "Why another article about this trite subject?"

There seems to be, however, a growing percentage of teachers who stand for an entirely different point of view in the management of clubs. In the past this view has not been stressed or even advocated widely and, in consequence, has not made the progress that it merits.

Before presenting this slant on extra curricular activities let us first consider the prevailing practice of club organization. The theory back of the usual club methods has been that the club offers an opportunity to develop interest and to acquaint the pupil members with the management of club work as in real life, and at the same time give them a chance to develop their individual abilities along any given line. In addition, the election of officers and other such routine business is supposed to further afford the pupil members an opportunity to experience the working of social activities as in real life. Clubs of this type have been known to have a membership of over one hundred members. In many cases this is too large a number for effective work. These clubs attempt to cater to those pupils who may happen in at the first meeting of the year, or perhaps the pupils assigned to the club either by choice or by management of the school.

It is my belief that these clubs do not function effectively in practice chiefly because the situations under which they operate are too artificial. There are several conditions that make these situations unreal. First, these clubs very often run on a time schedule. This is contrary to grown up organizations. Second, the pupils are sometimes required to join clubs. In a democracy like ours, this again is contrary to adult life. Third, because of a group of disinterested pupils who are required to join a club unwillingly, considerable domination on the part of the advisors is necessary. Due in part to these conditions, in part to others, the club period soon becomes

merely a socialized recitation period with a pupil in the teacher's chair.

Instead of having a club organized simply to imitate real life situations let us accept the definition that the school is life itself and *organize clubs for definite needs in that life.* Let us suppose that there is need for some real service. This must be real work, otherwise it is not a real service. Consequently, someone must do it.

Janitorial service has been notorious for its reluctance to accept additional burdens, especially after the regular work has once been assigned. Teachers are already burdened with numerous extra teaching duties and so very often pupils are drawn in to do service. Naturally, a teacher wishing to have the work done calls on that pupil best qualified to do that particular job. Right here is the essence of real club activity. Under this condition there is no longer any need to imitate. Too many artificial situations are already practiced in the regular classrooms of the school. Why carry this over to places where real service needs actually exist?

Why not take advantage of this situation by selecting for membership in clubs those boys and girls especially fitted for certain types of work? Clubs have not catered to this type pupil who is more advanced than the usual run of ordinary club members. It is precisely these boys and girls who will, in all probability, be the leaders in their particular line of work and should be the members to make up the club in which the predominant motive is service.

I have observed the development of a club of this type during the past four years and its activities are here presented as examples of the above principle.

In the first place the club is restricted in its membership: twenty members in a school of twenty-one hundred pupils. The method of gaining membership is a selective one. At the second or third month after school opens a committee of the members visit each science teacher and inquire as to the outstanding pupils as shown by their interest and their work. A list of the names is compiled, about twice as many names as there are vacancies in the club. These pupils are then formally invited to present

themselves at a stated meeting prepared to present a paper of approximately five to ten minutes in length. The members ask the candidate questions on his paper. (Let it be said that this question period is of the highest type not to be compared to certain professional fraternity initiations). At the next meeting the members vote on the candidates. The quota of members is usually left open so that at any time a worthy pupil appears he can be made a member.

The method is a highly selective one and the past years have seen the club with a waiting list of from five to ten candidates, either having already read their papers or requesting the privilege of doing so. Besides this scientific requirement candidates are chosen for their ability to add to the club's school and community services as well as to the club's prestige. A candidate's scholastic standing is second to his ability to add to the strength of the club. A pupil's grade is not a measure of his worth to perform service.

The officers of the club consist of a president, vice-president, secretary-treasurer, and editor-librarian. The business of the club is in the hands of the executive committee composed of the officers and the faculty advisor.

For the purpose of better handling the various services which the club performs it is divided into sections, each with a chairman who is directly responsible to the president.

These sections are: (1) The Projection Section. (2) The Photographic Section. (3) The Radio Section.

The projection section has for its purpose the job of school and community service. It serves the school by furnishing a projection lantern ready for use in any stated room in the building and an operator when requested. To accomplish this service a memorandum is kept in the science office. Any teacher wishing this service may simply write his need here a day before the lantern is wanted. The chairman of the section has a list of members with their free periods throughout the week and it is his job to call on them for this service. It is also the work of this section to instruct new members in the use of the projection equipment owned by the school.

Lantern slides are also made by this section upon order of teachers. Seasonal songs and athletic rallies are improved by visual aids of this kind and the cost is very slight. Social service and church organizations of the community have availed themselves of this service. Keeping the eight hundred slides which the school now possesses in order and properly catalogued is also the work of this section. For the assembly programs this section functions as a stage crew in charge of lighting, curtain and projector when necessary.

The photographic section performs many valuable services. It takes care of the school's dark room and its equipment; assists the projection committee when photographic slides are wanted; takes pictures on all important occasions of the school, including games, pageants, May Day, individual pictures of prominent pupils in other activities and so on. The chairman is usually staff photographer of the school paper and his assistants and other members are on the school magazine and yearly record book. This section also performs the service of amateur photographer to the pupils and teachers of the school in maintaining a service to develop pictures and make enlargements at nominal charge. This money is turned over to the treasury.

The radio section is the newest one but promises to establish itself and perform a highly specialized and valuable service to the school. It already operates the amateur radio station, W3AWC, and, as soon as its present equipment can be improved, hopes to be granted an experimental short wave license. It has constructed a public address amplifier which it operates for the school at its annual May Day and in the auditorium when special function requires it. This is one of the features of the club and has placed its work not only before the whole school but before members of the school board and those people in the community who patronize the affairs of the school. This effect was achieved last May Day when the entire school of 2100 pupils drilled to a stirring march record amplified by the club's public address apparatus and the results of the numerous events announced to the spectators.

To illustrate the type of service which this group is capable of the following deserves mention. An article which was recently published in a popular radio journal needed some photographs and diagrammatical sketches. The photographs of the apparatus were made by the photographic section and the radio section made the sketches.

A few words about money may not be out of place since without money a really successful club is seriously handicapped. At the beginning of school a benefit at a local movie house is usually held. This furnishes a good start for the club's finances at the beginning of the year. We have found it advisable and satisfactory to assess dues, one dollar per year, payable in two installments, the first of which entitled the member to a membership card. These cards were printed in the school print shop. The club is a member of the school audit system which is not only convenient but makes for efficient accounting.

The club, through its editor-librarian, publishes every school month a mimeographed journal. This journal contains current scientific news and a large part is given over to experiments performed by the members, either at home or in the club's laboratory. It also includes news of ex-members who are in industry or at college. The journal consists of ten to twelve mimeographed sheets, known as the Steinmetz Journal. An interesting phase of this work is the fact that the stencil cutting and mimeographing is performed by commercial students, who, although not members of the club, have volunteered for the service.

Situated in the laboratory is a small scientific library which has been gradually built up by the members. The plan to be placed in operation this year is to permit members to use the club laboratory for study periods instead of the regular study halls. A duplicate of all the reference books used in the physics and chemistry course is on the laboratory shelves. A typewriter, pencil sharpener, paper clipper and other office equipment are already in the club laboratory for this purpose.

Among the activities which the club has found not only interesting to itself but to the welfare of the school has

been the sponsoring of a device contest. This contest was open to every student in the school. Prizes were given by the club for the three best scientific devices made and submitted by students. Many were turned in and an exhibit was held in a corridor of the school. The winning devices were: a phonedeik that actually worked, a reverberatory furnace that required a truck to bring it to school, and a model airplane which flew a distance of several hundred feet.

Another way of obtaining the recognition of the student body and at the same time furnishing a real motive for activity in the club was the presentation of an assembly program. The club, after many months of effort, put on a fifty minute program before the school. One of the outstanding stunts of the performance was an address by the principal of the school delivered from his desk in his office to the assembled students in the auditorium by means of a microphone and amplifier system.

A feature of this past year's activities which I believe to be unique in high school organizations is the Club Classes. The club selected four of its most advanced members, each to give a series of six lectures in one of four fields. The fields were determined by the particular aptitudes of the boys chosen to give them and the lectures included chemistry (Mendeliff table), radio, photography and nature study. Anyone in the school could attend the lectures, but to insure regular attendance and good faith, a deposit of twenty-five cents was required. This deposit was returned provided a student attended four of the six lectures in any one of the series for which he signed up. The clerical work of registering, collecting the deposits, issuing receipts, taking attendance and so forth was done by a member called the registrar. The lecturers made outlines of their talks, one lecturer actually passing out mimeographed outline sheets to his auditors. The scheme was very successful and will be continued this year.

The club also took the initiative of forming the Inter-suburban High School Science League. This league grew out of the desire of several of the boys to invite a selected group from other nearby high schools for the interchange

of ideas. The plan finally culminated in a joint meeting of twelve suburban high schools, represented by a gathering of one hundred and twenty. The program was divided into an afternoon and evening session, our club being the host at the dinner which was served free of charge to the three official delegates from each school. The afternoon session included demonstrations by students from two visiting schools and our own and an illustrated lecture by a university professor. The evening session, following the talk by another professor, was characterized by wholesome inter-school goodwill. At the dinner an advantage was taken of the opportunity to cooperate with other school activities as the Hi-Y girls served the dinner. It is the hope of the club to build up a league whereby the interchange of programs will be of mutual benefit.

Other activities performed by individual members of the club are: Setting up lecture demonstration apparatus for science teachers, sometimes actually assisting in the demonstrations; constructing new and repairing broken apparatus, acting as electrician for the operetta, senior and junior plays; setting up a sun dial and other similar services.

SCHOOL LIFE.

School Life, official organ of the Office of Education, has been given the task of unlocking a hoard of material consisting of publications, maps, pictures, etc., valuable to the schools. *School Life* will report the educational activities of the United States Government wherever they may be found, in departments, bureaus, commissions, and boards.

Three great, national surveys conducted by the Office of Education; the Land-Grant College Survey, the Secondary School Survey and the National Survey of the Education of Teachers, will also be reported from month to month in *School Life.* This official information service represents the quickest way in which the Office of Education can get the findings and preliminary reports of its research and statistical studies into the hands of teachers and administrators.

While work of the Office will take first place in *School Life,* the conclusions of such bodies as the National Advisory Committee on Education by Radio, the White House Conference, and the educational work of the National Park Service, will also appear. Teachers will be able to learn through its columns of educational films available from certain bureaus and special maps and picture material from others. Send 50 cents to the Superintendent of documents, Washington, D. C., for a year's subscription to *School Life.*

THE USE OF ATOMIC MODELS IN TEACHING CHEMISTRY*.

By W. H. McLain,
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The following models of atomic structure are simple and inexpensive and can be used to illustrate the supposed mechanism of a variety of chemical phenomena. They are easy to manipulate, and occupy very little space when not in use.

The models were made from kiln dried sandpapered spruce, one foot square and three fourths of an inch thick, they were lacquered white on both sides. A black circle eight inches in diameter was painted on each side of the first model. The hydrogen atom was diagramed on one face by painting $\overset{\mathrm{H}}{1+}$ inside the circle with black paint, this represents the nucleus of the hydrogen atom. A wooden orange peg one inch long fitted into a three-eighths inch hole bored half way through the board on the margin of the black circle represents the valence or removable electron. The reverse side of the model is used for the helium atom, nucleus $\underset{2-}{\overset{\mathrm{He}}{4+}}$, the two nonvalence electrons outside the nucleus are given as two orange pegs set flush with the board on the circumference of the circle.

Figure 1 shows a blank atom for the second series of the elements. The small solid black circles represent the two nonvalence electrons outside the nucleus. The eight circles are holes into which orange pegs can be fitted to represent the valance electrons of any element of the second series. The nucleus of each atom of the second series is printed on a separate sheet of white cardboard that can be fastened by a thumbtack in the inside of the innermost circle. The printing on these cards are:

Li	Be	B	C	N	O	F	Ne
7+	9+	11+	12+	14+	16+	19+	20+
4−	5−	6−	6−	7−	8−	10−	10−

A free nitrogen atom is made by fastening the nitrogen nucleus by a thumbtack on the inside of the large circle. The two nonvalence electrons outside the nucleus are represented by the orange pegs set flush with the board, and the five valence electrons by the five removable orange pegs fitted into five of

*Given before the Educational Division of the American Chemical Society, Chicago Section, December 19, 1930.

the holes in the outside circle. The positive and negative charges will then add to zero. This can be changed into any one of seven other atoms of the second series by pinning on the appropriate nucleus and adjusting the number of outside electrons (removable) to make the electrically neutral atom.

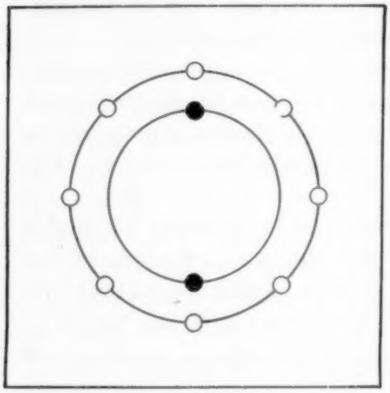


Fig. 1.

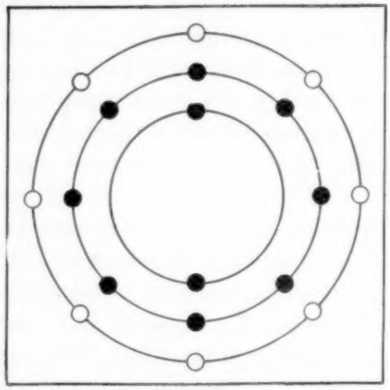


Fig. 2.

Figure 2 represents the reverse side of the atomic model. Here the electrons in the first and second ring are set flush with the board and holes are bored in the third ring into which valence electrons may be fitted. Diagrams as given below are printed on the reverse side of the nucleus diagrams for the atoms of the third series:

Na	Mg	Al	Si	P	S	Cl	Cl	A
23+	24+	27+	28+	31+	32+	35+	37+	40+
12−	12−	14−	14−	16−	16−	18−	20−	22−

By the use of this face any one of the nine atoms (counting the isotopes of chlorine) or eight ordinary atoms of the third series can be diagramed; i. e. chlorine; pin the nucleus card of the chlorine atom to figure 2, seven removable electrons (orange pegs) would be required in the outside ring to make the electrically neutral free atom.

The multitude of situations which can be illustrated by these models will be readily apparent to the teacher who uses the modern atomic structure in his teaching. A possible list follows:

1. In the form of the free atom, intact, during the early part of the course to illustrate building of compounds from atoms.

2. Use of compounds built from these atoms to illustrate balancing equations.

3. Given the atomic number and atomic weight, to build up the atomic diagram.

4. Emphasize the characteristic structures of metallic elements and their tendency to lose the electrons in the outer ring.

5. Emphasize the characteristic structures of non-metallic elements and their tendency to fill the outer ring to a stable configuration of eight valence electrons.

6. Illustrations of typical combinations of metals and non-metals:

(a) Sodium and chlorine; the sodium atom loses an electron to the free chlorine atom. This leaves the sodium atom after combination with no electrons in its outside circle and fills the chlorine to a stable configuration of eight.

(b) Hydrogen and oxygen; showing two hydrogen atoms uniting with one oxygen atom. The hydrogen atoms lose one electron each to fill the oxygen from six to eight.

(c) Aluminum and oxygen; visualizes to the student why two aluminum atoms unite with three oxygen atoms and also indicates the valences in the compound Al_2O_3.

7. To illustrate that valence, in terms of the number of electrons gained or lost by each element, is on the same basis as valence in terms of hydrogen atoms united with or displaced.

8. Isotopes have the same electronic structure in the outside rings, therefore should have the same chemical properties.

9. To illustrate periodic relationships:

(a) Families have similar atomic structures.

(b) The heavier atoms, in a family, having electrons farther from the nucleus lose them more easily, hence are more electropositive.

(c) The lighter atoms have a more powerful pull for electrons, their valence ring being closer to the positively charged nucleus. This is especially clear with the non-metals.

10. Explanation of electrolysis. Recognition of changes as due to the loss and gain of electrons.

11. Explanations involving oxidation and reduction equations. In a reaction such as hydrogen sulfide reacting with dilute nitric acid to form water, nitric oxide, and free sulfur, have the student work out the atomic diagram for sulfur in the compound H_2S and in the free form. He can then see what electronic change has occurred. Have him explain the change in the nitrogen atom in a similar fashion. Then have him

balance the loss of electrons by the sulfur by the gain of electrons by the nitrogen.

12. Illustration of simple replacement reactions as gain and loss of electrons.

13. In the study of any given element have the atomic model of that element before the class and have them guess at its probable chemical behavior, or study the behavior of the element then build the significant part of the atomic structure based on this behavior.

14. Use of the plus charges in the nucleus as indicative of the weight of the atom and use the models to aid the student in visualizing weight relationships in problems.

Two primary essentials in the modern high school, with its multitude of duties, are speed and simplicity of apparatus. The above models require only a small box partly filled with cards, thumbtacks, and pegs for their use. They stack easily and take up very little space when not needed. They can be used advantageously in at least one-third of the class periods of the year. It is not intended that they represent to the student the real picture of an atom, however in the light of modern explanations of atomic structure, they do give a working concept.

A kit of nine models, three of the hydrogen and helium type, and six of the blank atom type for the second and third series, are sufficient to illustrate many of the situations. The cost for material and paint is about three dollars.

Possible improvements or variations in the construction might be:

1. The use of colored thumbtacks instead of the orange pegs.

2. A card holder with crimped edges into which the nucleus cards could be slipped.

3. A bracket attached to the back to facilitate standing the model on the desk. This however might interfere with stacking when not in use.

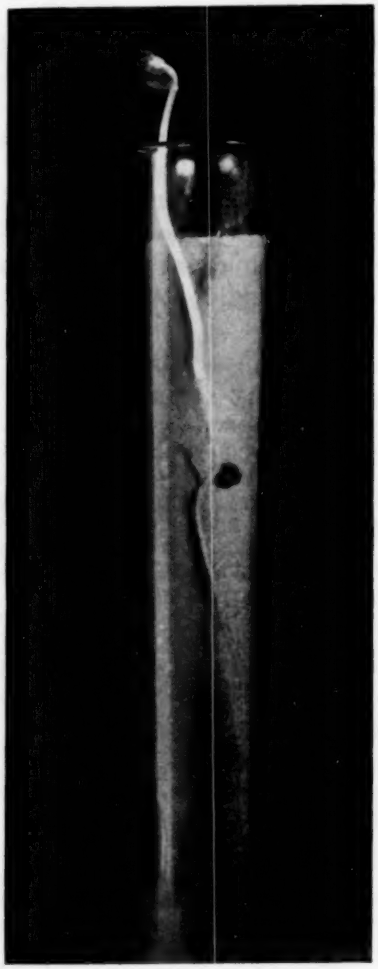
4. A hinge set flush with the bottom edge which could be folded back to aid in setting the model upright on the desk.

Mount McKinley, Alaska, is higher than the loftiest peak in the United States, Mount Whitney, would be if the highest peak in the Adirondacks, Mount Marcy, were piled on top of it. Mount McKinley, according to the Geological Suvrey, Department of the Interior, is 20,300 feet above sea level; the combined height of Mount Whitney and Mount Marcy is 19,840 feet.

ROOT HAIRS FOR CLASS USE.

By William G. Kirby,

Oak Park-River Forest Township High School, Oak Park, Ill.



If you have been provoked almost to the point of tears or profanity, depending on your own disposition, and limitations in vocabulary, by the destruction of your carefully prepared samples of delicate rootlets, for individual work with your laboratory sections, you will possibly be able to make use of the method described here.

For some years the writer has tried various ways of growing radish roots to supply classes of twenty-six with individual samples in order to have each member of the class working at the same problem at the same time. In every case the result has been the same. The first class, thoughtlessly, of course, succeeded in making many of the samples useless by getting the delicate root hairs wet or by allowing them to dry out or by matting them down through careless handling.

The following plan was suggested by a freshman girl in one of this semester's classes. She brought to school a pea seed sprouted in a tumbler by inserting it between a blotter curved around close to the glass with its lower edge under water. The seedling has developed splendid roots reaching down into the water and the top had

grown several inches above the top of the tumbler.

The idea seemed good enough to try with my radish roots. On a Friday I cut strips from blotters long enough to reach water an inch to an inch and one-half deep in the bottom of a test tube and wide enough so that some parts of it would be pressed against the sides of the tube.

Next I inserted two radish seeds in each test tube. The two seeds were used to make sure at least one would grow. The blotter kept the seeds moist by capillarity and on Monday well developed root hairs had grown in every tube. In some cases the roots were three inches long.

This gave me a supply of tubes sufficient for every pupil in the class and after one section had used them they were still in good condition for two succeeding classes. This is a time and temper saver that I am finding helpful and I trust may be useful to others.

NEW UNIT OF ATOM NEEDED BY SCIENCE.

Scientists are now on the hunt for a new basic unit weight of matter. Chemists have in the past used the atom of oxygen as the unit of atomic weight, calling it 16.

Dr. F. W. Aston of Trinity College, Cambridge, in a communication to scientists printed in Nature, has raised the point that since there are now three known varieties of oxygen atoms, known as isotopes 16, 17 and 18, the actual weight of the average atomic weight of the element oxygen is about 1.25 parts in 10,000 greater than the customary 16 assumed in chemical books.

While chemists might get along with the present standard, Dr. Aston intimates, physicists who compare the weights of individual atoms by means of the mass-spectrograph with an accuracy of 1 in 10,000, need a new and more definite unit.

Among the possible units suggested are: the proton or positive nucleus of the hydrogen atom, one-quarter of the neutral helium atom, one-sixteenth of neutral oxygen atom 16. But none of these proposed units is entirely free from objection.—*Science Service.*

The John C. Winston Company, Educational Publishers, have announced from their Executive Offices in Philadelphia the appointment of Loyd F. Gehres as Manager of the High School and College Department, to succeed the late George A. Helms.

Mr. Gehres, who is a graduate of Ohio State University and did post-graduate work in education at Columbia University, has been associated with The John C. Winston Company for the past twelve years, in charge of the Ohio Division. He will devote his entire time to the promotion of The Winston Simplified Dictionary, Commercial, English, Mathematics, and Modern Language texts in high schools and colleges. He will be located in Philadelphia.

We extend our best wishes to Mr. Gehres and congratulations on his new position with this large and progressive organization.

THE NEWNESS OF SCIENCE IN THE PUBLIC HIGH SCHOOL CURRICULUM.

By A. C. MONAHAN,
Formerly U. S. Bureau of Education.

A high school teacher offers, as an alibi for the decreasing percentage of enrollment in the science classes in the public high schools, the statement that it is due to the newness of the subject in the curriculum, that when the science courses were first included in the course of study there was a tendency on the part of students to enroll as they seem to do in most "new" subjects offered. Now, he says, we have passed the first period and the enrollment has settled down to "normal." The fact is, that science can hardly be regarded as a new subject in the high school course of study. It was a required subject in the first public high school in the United States and has been either a required or an elective subject in practically every high school established with the exception of a number of the smaller schools.

The Boston High School for Boys, opened in 1821, is generally credited with being the first free public high school in the United States. There were many secondary schools prior to that date but they were Academies and under private or church control. In the course of study for the Boston High School for Boys, Natural Philosophy was included as a required subject for all pupils in the fourth year. Three years later it was made a required subject in the second year, and "experimental lectures" in Natural Philosophy was required in the fourth year. When the Boston High School for Girls was opened in 1826, Natural Philosophy was required in the second year, and botany and chemistry offered as electives to upper class girls. Practically all other public high school as established followed the lead of these two Boston schools and included Natural Philosophy and sometimes other sciences in their course. The number of schools was small, of course, there being approximately 70 in the entire United States in 1850, according to the U. S. Bureau of Education. From that date on the number increased rather rapidly, the real rapid expansion occurring during the past forty years.

Secondary education during the colonial days and the first 75 to 100 years of the Union, was left almost wholly to the private and church academies. There was something like 6,000 of them in the country in 1850, with over 260,000 pupils. Many of these pupils were in elementary work and not in secondary school subjects at all. Just how many can not be said. These academies were largely college preparatory institutions, and confined their work to the subjects that the colleges would accept to satisfy entrance requirements. Ancient languages, mathematics, history, literature and English were the usual subjects of the curriculum. It was not till 1870 that any college recognized any of the sciences as satisfying their requirements for entrance, then Harvard and the University of Michigan permitted candidates for entrance to offer Physical Geography. In 1873 Syracuse University permitted Natural Philosophy as an entrance subject. Other colleges followed this lead and the academies then began to include Natural Philosophy and other sciences in their courses.

So the study of the sciences in the high school can not be regarded as something new. The science subjects have changed and the methods of teaching have changed but even these changes can not be regarded as particularly recent. The science courses in the first half of the century were almost wholly informational, during the last half they were emphasized as pure sciences. In the nineties came a change. The applications of science were beginning to be emphasized. The public was beginning to take interest in scientific developments. Electricity was coming into general use for lighting and power. The gasoline internal combustion engine was entering the power field, automobiles were becoming a reality, telephones were in many homes, telegraphic communication was more or less common, and the chemists had developed foods and medicines not before thought of. Science became in the popular mind, no longer an abstract subject, but a practical, living subject with applications undreamed of before. Courses were demanded that would prepare for explorations into these new fields. Laboratory experiments and research became necessary in

teaching. Textbooks were to assist the laboratory course, instead of being the entire source of information as in previous years. The method has changed little since.

A great impetus was given to this movement for the teaching of high school sciences from the utilitarian standpoint by the report of the famous "Committee of Ten" of the National Council of Education, appointed to consider the problems of secondary education. This report was issued in 1893. The studies made by it during the two or three years preceding the report were during the years when the movement was well under way to replace the informational and "pure" science courses with practical courses, taught through the laboratory method. Chemistry was becoming an important laboratory subject. Natural Philosophy was changing in name and contents to Physics; Botany and Zoology which had been largely the systematic classification of plants and animals, was beginning to turn to the study of life and life processes under the title of Biology. Astronomy, Meteorology and Geology were beginning to pass from the curriculum. The committee realized these changes to a large extent. Dr. J. H. Baker, then president of the University of Colorado, who wrote a critical review of the committee report for the Annual Report of the U. S. Commissioner of Education, realized them more fully. The Committee of Ten listed the subjects that it thought ought to be included in the high school science work, the order in which they should be taught, the time that should be devoted to each, and the method that should be followed in teaching. It advocated strongly individual laboratory work for the students, and field trips particularly for those in botany, zoology and physical geography. It specified that twenty-two and one-half per cent of every pupil's time, except those in classical courses, should be devoted to the sciences. For the classical students it specified eighteen percent of the time for the sciences.

Dr. Baker agreed to the time allotment and the methods of teaching the sciences, but stated the committee included too many sciences. He suggested that four only be given, these four being as he saw it, the "most im-

portant high school sciences": Physical Geography, Biology, Physics and Chemistry. He said "It is better to pursue four sciences, each one year, than to take twice that number with a half year for each." Time has proved Dr. Baker to have been right, although General Science has now taken the place of Physical Geography, and Chemistry usually is given preceding Physics in the high school course. General Science, Biology, Chemistry and Physics has become in common practice the science course in the four-year high schools of the country, one year of from 5 to 7 school periods a week each, and given usually in the order named.

Since the time of the report of the Committee of Ten the applications of the sciences in everyday life have been more and more emphasized. Their practical value continues to be one of the principal objectives in science teaching in the secondary school. In addition to this utilitarian value the sciences have a vocational value for many. Many high school teachers have lost sight of this fact, and are devoting their time entirely to college preparatory courses in which they give too much of their energies to the theories and mathematics of their subjects for most of their students. They are taking too much time for recitation periods and for instructor-demonstration-lectures and neglecting the individual laboratory student work which is the essential part of a vocational course in many ways. Laboratory technique is what the students will use mostly in the jobs to which they will go when they finish their high school courses, at least for the first months of their employment. They will be helpers in laboratories, do routine testing in connection with some manufacturing operation, or perhaps be assistants on outside installation work. They will need plenty of information on science subjects but their work will be largely manual.

This is shown by a recent study made by Herman A. Ernst of the Essex County Vocational Schools, Newark, N. J. The results were presented at the recent meeting of the American Chemical Society and are printed in *Journal of Chemical Education* for February, 1931. Mr. Ernst set out to find out just what kind of work was being

done by high school chemistry graduates employed in chemical manufacturing establishments in the vicinity of Newark, in order to have definite information on which to shape his course in this subject. He got the information relative to the work of 82 laboratory assistants or "junior laboratory technicians" in 40 plants. He listed 50 jobs or duties performed by these boys. The employers checked those which their helpers were required to do. In the order in which the jobs were most frequently required, the first of the list is as follows: clean apparatus, take samples, prepare samples, use electric oven, take specific gravity, grind samples, use hot plates, determine moisture, use analytical balance, measure temperature, set up apparatus, use corrosive chemicals safely, use inflammable chemicals safely, match colors, measure time with stop watch, weigh on balance to 0.02g., titrate acids and bases, use sieves, determine flashpoints, determine viscosity, make distillations, use oilbath, use Buchner funnel, use siphon, make ignitions, make filtrations, make evaporations, use qualitative tests, use separatory funnels, use analytical tables, determine melting point, determine boiling point, and titrate, oxidizing and reducting. These are the first 33 of the 50 jobs. The others are more technical for the most part, but are not common to many plants. They indicate clearly what the pupils need in their courses if they are to go into these kinds of occupations, science information but plenty of practice in laboratory work in the use of simple apparatus and materials.

The newness of science in the curriculum can hardly be legitimately offered as a reason for the decreasing percentage of enrollment in the high school science departments. Failure to recognize both the utilitarian and the vocational value of the sciences, has been more responsible. Sciences have not kept up to the percentages of enrollment because other utilitarian subjects have come into the curriculum and taken the students, because they are frankly utilitarian and advocated as such by their instructors. Home Economics teachers, commercial teachers, and instructors in the industrial arts, agriculture and drafting, all keep constantly before their pupils and their

public that their subjects have a practical value as well as an educative one. The constantly increasing percentage of enrollment in these subjects show that the instructors mentioned have found out the way to increase interest in their departments, and they deserve great credit for the important place in the high school curriculum which they have made for themselves. When teachers in the classics, mathematics, history, etc., found a few years ago that the sciences were attracting the students away from them, they developed and advertised the "laboratory method" of teaching their subjects, better called the "project method." Today the science teachers have a lesson to learn from instructors in the newer subjects in the curriculum just mentioned.

WEALTH FROM THE EARTH.

Of the 1,500 mineral species known, only 200 figure in commerce as mineral resources. As crude mineral ore the world's output amounts to over 2,000,000,000 tons annually; this figure, however, excludes water but includes petroleum.

Most of this enormous quantity of minerals is burnt up, as 70% is coal. The next in importance are stone and clay 10%, iron ore 9%, petroleum 4%, copper 3%, and the less important ones make up the remaining 6%. Enough mineral ore is extracted annually, that if it were spread over one square mile it would cover it to a depth of 2,300 feet.

Two-fifths of this great amount of material produced by U. S. is iron ore. Forty per cent of the total valued at over $2,000,000,000 is exported. Our mineral import costs us in the neighborhood of $500,000,000 annually. Many of these are in small quantities but of great economic importance.

EGYPTIAN TOMB DISCOVERY IMPORTANT TO SCIENCE.

The tomb of an ancient Queen of Egypt, which has now been discovered in the Ra Ouer tomb enclosure close by the Egyptian Sphinx, is a find of more than ordinary importance, Prof. James H. Breasted, noted Egyptologist, of the Oriental Institute, considers.

The discovery, reported to include the sarcophagus of the queen and royal household furnishings such as gold toilet articles, alabaster statuettes, a bed and other furniture, brings a group of valuable new materials to light, Prof. Breasted said. Besides the value of the discoveries themselves, the Ra Ouer tomb excavations are "of more than ordinary importance, marking the beginning of native Egyptian participation in archaeological research," he added.

The excavations are conducted under the direction of Selim Bey Hassan, archaeologist, of the Egyptian University. The new-found royal tomb may belong to the mother of Mersa-Ankh, is the tentative belief.—*Science Service.*

A COMPARISON OF THE ANALYTIC AND SYNTHETIC METHODS OF TEACHING GEOMETRY.

By LEMUEL PITTS AND ROBERT A. DAVIS,
College of Education, University of Colorado.

An article appeared in 1919 entitled, "Teaching Geometry by Analysis."[1] The usual text book plan of presenting the demonstration of theorems was designated as synthetic, the plan proposed was called analytic. The procedure after the first few steps was the reverse of that used in ordinary plans. The first steps were regular; the stating of the theorem, hypothesis, and the particular thing to be proved. The main specific requirement, i. e. prove triangles ABC and DEF congruent, was to be stated as the first major premise, supported, if true, by a theorem, postulate, or some geometric truth. This major premise was to be supported by one or more subsidiary facts called minors, with authorities of immediately apparent. If there was no immediate authority for the minor, each minor in turn became a major with the same steps as before. This procedure was to be continued until each major with authority, and each minor with authority was established, and then the demonstration was complete.

In other words, the method of proof proposed was the reverse of the ordinary synthetic method. The last evidence became the first minor in the analytic, and the first evidence in the synthetic became the last minor in the analytic.

The arguments for the plan were not based upon objective investigation, but upon subjective observation. The author held that the pupils became more skillful in seeing the new problems of each step from unsupported minor to new major; that the pupils developed more initiative and independence; that pupils were more efficient in demonstrating originals because of familiarity with the standardized method of approach; that slow pupils were helped and bright pupils were accelerated.

The plan entailed the use of a special form paper, with one column for majors, one for minors, one for major authorities, one for minor authorities. It was so attractive, the line of reasoning was so cogent and convincing, that Central High School, Pueblo, Colo., adopted the plan in toto

[1]Barnes, H. O., Geometry by Analysis, School Review, October, 1919.

in January, 1920, and had the paper printed. The system was heartily approved by the teacher who started the plan, but at the end of seven years the work had been passed along through a cycle of teachers and doubts arose as to its efficacy.

In September, 1927, it was decided to test the plan objectively, using the equivalent group technique. There were four classes, two teachers of equal mathematical training and teaching experience, each having used the analytical method one year. The chance equating of the groups was good so far as intelligence was concerned. Using the Dearborn Intelligence Test, Series II, Intelligence Quotients were found to be as follows:

	Group A	Group S
No. Cases	49	45
Range	69-133	73-132
Mean	109.768	108.1
S. D.	12.7	12.14

At the end of March, 1928, after semester elimination there was another check on intelligence with results:

	Group A	Group S
No. Cases	37	33
Range	90-133	83-132
Mean	112.23	110.47
S. D.	10.09	9.624

It would seem that for the purposes of the experiment the groups were reasonably equated throughout. To further check the equating an information test on preliminary geometric facts was given before any work in demonstration was attempted. This test included definitions, axioms, postulates, etc., with the following results:

	Group A	Group S
No. Cases	48	46
Range	17-48	17-48
Mean	37.08	38.78
S. D.	6.82	6.22

The reliability of the test by self-correlation was .854.

The work of the experiment was divided into units with certain definite theorems, corrollaries, and originals to stress. Tests were prepared for each of the units with a final one at the end of Book I[2]. All tests were prepared, questions evaluated and scores translated into percentages of achievement by one person. Tests were given under the

[2]The text used was Durell and Arnold.

best conditions possible to equalize opportunities and avoid coaching. In these tests emphasis was laid on approach and demonstration of simple originals to avoid the effects of memorizing. One semester was devoted to Book I. At the end of the time all pupils were put on the synthetic method. This put Group A (Analytic) to the necessity of learning a new method, while Group S (Synthetic) continued with a learned method. Nine weeks elapsed before another test was given. This test was on similar figures. On May 17, a final test was given.

The initial test on demonstration was given Nov. 1, 1927. This covered the first fifteen propositions in Durell and Arnold with the accompanying exercises. Theorems involving superposition were not given because the two methods paralleled. The results of the initial test on demonstration were:

	Group A	Group S
No. Cases	47	44
Range	20-99	11-99
Mean	52.052	15.776
S. D.	17.376	24.072

All scores presented are percentages of correct achievement and are not raw scores, since the total raw scores with the evaluating varied from time to time and were not comparable. A few were always able to complete the tests in the allotted time. It would seem from the initial test that the analytic method had a slight advantage over the synthetic at the start.

Some more practice tests were administered and the first final test was given on Dec. 16, covering thirty-eight theorems with accompanying original in Book I. The test was given over entirely to originals. The purpose of this test was to measure progress in the power of demonstration between Nov. 1 and Dec. 16. The results were:

	Group A	Group S
No. Cases	45	42
Range	24-100	24-99
Mean	57.68	63.833
S. D.	19.192	22.224

This test was given before the semester elimination of failures and the figures include the low scores of those who were to fail. Group A had gained 5.528 points as against 12.057 for Group S, points as based on percentages of possible achievement.

On January 10 was given what may be termed a second initial test. Originals of considerable difficulty were given and the results tabulated question by question. It was a two-day test of originals which the pupils had not seen or practiced. Group A made an average raw score of 77.49 points and Group S an average score of 85.33 of a possible score of 193, showing an advantage for the synthetic method of 7.84 points on this test.

On March 26, nine weeks after Group A had started on the new method, a test on similar figures was given. In the meantime many pupils in Group A had expressed their satisfaction at having given up the analytic method with its mechanics of form, special paper, and its majors and minors. None of the group expressed a desire to return to the synthetic method. The results of the test were:

	Group A	Group S
No. Cases	37	32
Range	32-100	56-100
Mean	78.024	83.000
S. D.	17.33	14.356

On May 17 a final test was given the results of which were:

	Group A	Group S
Range	31-87	11-100
Mean	46.865	40.125
S. D.	21.245	26.02

	Group A			Group S		
	Range	Mean	S. D.	Range	Mean	S. D.
Nov. 1	20-99	51.052	17.37	11-99	51.77	24.07
Dec. 16	24-100	57.58	19.192	24-99	68.833	22.22
Mar. 26	32-100	78.024	17.33	56-100	83.00	14.356
May 17	13-87	46.865	21.245	11-100	40.125	26.02

Gains as related to previous scores were:

	Group A	Group S
Nov. 1 to Dec. 16	10.6%	23.2%
Dec. 16 to Mar. 26	35.5%	30.0%
Nov. 1 to Mar. 26	49.9%	60.5%

Another way of stating the relation is that from Nov. 1 to Dec. 16, Group A made 45.8% as great progress as did Group S; from Dec. 16 to Mar. 26, Group A made 101.4% the progress made by Group S. With the slow start on progress from Nov. 1 to Dec. 16 of 45.8%, Group A using the synthetic method increased its total relative gain to 83% of that made by Group S.

The figures thus far included all those who were eliminated at the end of the semester and were not to continue to the end. A further investigation of the survivors Mar. 26, shows that of the pupils who started and remained through the year in Group A progress between initial and first final was 39% as good as that of Group S, but from first final to second final (Dec. 16 to Mar. 26) Group A using the synthetic method made 129.3% the relative progress made by Group S on previous scores.

Some study was made of the relation between intelligence and rate of progress under the two methods. The following facts were noted:

1. Neither method affected the achievement, progress of those below 80. I. Q., all being eliminated by failure.

2. For those between 80 and 90 I. Q. there was no advantage in achievement and rate of progress for either method. Four were eliminated and two survived. The two survivors did, however, improve under the synthetic method.

3. Those between 90 and 100 I. Q. made better progress when using the synthetic method.

4. For those between 80 and 100 I. Q. elimination and failure were greater under the analytic method, eight dropping from Group A as compared with five from Group S.

5. For those between 101 and 120 I. Q., those in Group A made less progress under the analytic method but gained perceptibly when using the synthetic method.

6. For those above 120 I. Q. Group S made better progress throughout.

7. In all cases of very low or very high I. Q. there was a slowing down for Group A to learn the analytic method and to master the mechanics of the procedure with no attendant later compensation when learned.

8. No conclusions can be drawn as to the benefits of either method for those below 100 I. Q. The argument that the analytic method helps the lower levels was not substantiated by results. There was greater elimination at this level, below 100 I. Q., among Group A.

9. Pupils of intelligence, 100 to 120 I. Q., were at a distinct disadvantage during the use of the analytic method,

facing a lower achievement and a slower progress. When using the synthetic method improvement in progress was quite marked.

10. No definite conclusion could be drawn as to those above 120 I. Q. because of the few cases and the many human factors involved.

11. For those of average geometrical ability the synthetic method was an advantage from the standpoint of total achievement and relative progress after all used the same method.

General Conclusions.

1. As a class procedure the analytic method as outlined when used as the only method of attack and solution acted as a hindrance, deterrent and eliminator.

2. As a method of approach and solution of originals, the analytic method when used alone acted as a hindrance rather than a help.

3. The elimination of pupils below the average in intelligence was greater under the analytic method. It did not help the duller pupils.

4. The mechanics of the form paper were so difficult that the slower pupils could not understand the system to use it and it was so cumbersome that it interfered with the thinking of the very bright pupils. The details of filling the proper spaces with correct majors and minors and authorities were so tedious that pupils lost sight of the demonstration and spent more time deciding in which column a statement should appear than in arranging a logical solution.

5. As Class A progressed with the synthetic form it advanced more rapidly. Probably the analytic method had necessitated more drill and greater familiarity with the subject matter of the theorems.

6. The comparison of achievement on two particular theorems given January 10 and May 17 showed that the synthetic method was a distinct advantage to those using it.

7. The mastery and use of the synthetic method came more quickly and thoroughly. It was much easier to learn, had fewer mechanical details to think about, and was the simpler to understand and express.

As a result of the experiment the analytic method, with

its form paper, as sole method of approach to the solution of theorems and originals was discontinued. The opinion of the pupils and the conviction of the teachers favored the regular plan. The analytic method without the form paper is still used as an occasional means of suggestion, but the synthetic method is used as the means of expression in geometrical demonstration.

THE SCIENCE NEWSPAPER.

By Ruberta Nelson,

Prince School, Boston, Mass.

The science newspaper was started by a group of boys who having an extra period of science a week decided to do something different from the regular work. The class was organized as a club, and the paper was part of the work accomplished.

There is so much of scientific interest going on in the world about us today; a new planet or a new element is being discovered; a new invention appears; a shower of meteorites or an eclipse is scheduled. Is it not the duty of our school science to help the boys and girls to appreciate and at least to partially understand some of these phenomena? Moreover, is it not true that most teachers are faced with the fact that the average child considers that what he learns in school belongs in school and has little or no connection with events occurring outside that particular environment? Consequently, it was with the idea of bringing the science of the outside world in closer contact with that of the schoolroom, and with the hope of causing the class to appreciate some of the wonderful things happening in the world around them that the science newspaper was encouraged.

Contents of the paper—In general, the contents of the paper can be classified into two groups.

1. Clippings of scientific interest from the daily newspapers. For example—the visit of Madame Curie to the United States, the observance of the Edison light jubilee, and various feats in aviation were a few of the selections made. Last year was particularly kind, it seemed to our editors, in having many outstanding events taking place.
2. Articles contributed by members of the class on

subjects which particularly interested them. The sources of the material were varied. Current magazines, science books, or best of all information obtained first-hand from their personal experiences or the experiences of their friends or families.

Current magazines. Of course, there are the science magazines which deal solely with scientific material. These were very helpful. Then there also appears from time to time articles in other periodicals having a scientific significance. For example, on weather forecasting, the work of some modern scientist, or on aviation. I speak of these because they were some of the articles commented on last year.

Science books. This source of material practically speaks for itself. To give an example, however, last year the geography class in studying Italy mentioned the two Italian scientists, Galileo and Torricelli. One of the boys was interested enough to look up and report on the lives and work of these two men. Another boy, whose present ambition is to attend Annapolis, gave a series of reports on the history and operation of submarines.

First hand information. In this particular group these concerned themselves principally with aviation. One boy, whose father was an aviator, was our chief authority on this subject, and gave us many interesting accounts. A visit to a weather bureau and to a newspaper also provided material.

Method of compiling: The boys pasted their clippings on paper or wrote out their reports and brought them into class where each read or spoke on his own contribution. They were encouraged to use simple experiments or blackboard diagrams to amplify the material they presented. Many of the experiments were those used in a regular science class, but used in this way they seemed to have a new meaning. At the close of the lesson these reports were handed over to the editor-in-chief who arranged them in order and put them in a folder.

On the whole, the work was very successful. It held the interest of the boys; opened a new field of reading to many of them; and gave a new meaning to their school work.

GENERAL SCIENCE CLUB NOTES.

By Francis P. Frazier,
Donald McKay Junior High School, East Boston, Mass.

In the Donald McKay Junior High School of East Boston, Massachusetts, two periods of each week are devoted to General Science in each of the seventh and eighth grades, and four periods a week in the ninth grade. Half of this time is taken up by recitation work in the home room, the other half is spent in the laboratory.

In this typical Junior High School of Boston, with an enrollment of about 1,100 pupils, there are intra-curricular club activities once a week for forty-five minutes during the last school period on Thursday. Each pupil in the school is allowed to choose a club, and the choice of the student is respected as much as possible. A pupil is put in a club of kindred activity, in case of overcrowding in one club. Naturally, there must be a wide variety of clubs each of which is a beehive of purposeful activity.

In the General Science Club, this year, there are forty-seven members. Experiments are performed by the teacher, then pupils are allowed to repeat an experiment, if it appeals greatly to them. Many experiments are suited for pupil participation and the keen spirit of rivalry may then be stimulated by playful contests among the different rows of the class.

The Lung Testing Apparatus (see Lunt and Haley Unit No. 3) is an experiment well suited for this type of work. Another experiment of this nature is performed by five pupils, one with a wooden rod, one with an aluminum rod, and one with a steel rod. The rods are one foot long and half an inch in diameter (see Tower and Lunt, *The Science of Common Things)*. Let each boy pick any rod he wishes. Have a boy in the class time the contest, to determine how long a rod may be held in the hand before the rods become too hot to hold. This play spirit can arouse startling enthusiasm in any class of budding scientists.

In this paper I might mention manifold methods of teaching, and glow with the flaming rapture of enthusiastic science teachers, but when all is said and done, familiarity with those general science experiments which

appeal to the Junior High School pupil is of utmost importance. Very often a luke warm science teacher is inspired by a lively experiment with the fire that spreads across an excellent demonstration. If some of the older teachers pass along to the younger teachers some of the tried and true experiments, this unselfish attitude will make General Science the lively subject it is, by its general nature.

Let me explain the difference between lively and ordinary experiments. The Bow and Drill Set, used to start a fire, is an experiment that grips the pupil's attention, even though a young teacher may fail to light the tinder. There is the glamour of the Promethean myth, the glory of the wild Indian days, the greatness of potential destruction connected with the very words, "fire." Every pupil wants to perform this experiment, and as the faint curl of smoke rises to the successful pupil's nostrils, he feels that ardent satisfaction that came to him who first wrested this great secret from the gods.

On the other hand, there is the intrinsically poor experiment which needs an inspiring teacher to arouse sustained and lively class interest. Take for example, the explanation of the thermometer as a class demonstration. Due especially to the smallness of the apparatus and the lack of action in the experiment, it takes a skillful teacher to convince the pupils that they have come to the laboratory for a worth while lesson.

In this paper I shall endeavor to describe one experiment which I think is especially fitted for a General Science Club.

Take a 500 cc. Erlenmeyer flask and pour in water to a depth of one inch. Using a two-hole rubber stopper, first place in one hole a glass tubing about a yard and

a quarter in length. Push down below water level when placed in flask. At upper end of glass tubing, attach a small piece of rubber tubing, and finally a short glass tubing that is pointed at the top. In the other hole of the rubber stopper, place a bent glass tube so that it extends just below rubber stopper. Also attach rubber stopper and a short glass tube. Place a Hoffman clamp over each short piece of rubber tubing.

Now let's go. Ask some pupils how they can get the water up the long glass tube. Some pupils blow in the short bent tube, and try to clamp the short rubber tube at the bottom, and thereby hold up the long column of water. It requires deft handling to make tight the clamp, and to keep the water well up in the column.

The next boy sucks up the long tube and tightens the clamp at the top. This method is easier. (Place apparatus on the floor for this performance.)

Now I ask a boy to lower the column of water by sucking at the short, bent tube. There is plenty of fun, especially if you start with a small, weak boy and then call on some big, strong boy to show how it should be done. There is consternation in the club when the column refuses to come down.

Are we to admit that the tiny column of water has us beaten? Not yet. There is an interesting way to take this stubborn column of water down without loosening any clamp. Place the apparatus on a tripod, tie upper part of glass tubing to a cross bar support if necessary, and heat water to the boiling temperature. When steam has come out of the short bent tube for a minute or two, remove apparatus from the heat and clamp tightly the smaller bent tube with a Hoffman clamp. As the water cools, the steam condenses, and the column of water descends until the pressure is equalized. Use a sponge of cold water to drive down the last few inches of the water. Use a strong Pyrex glass flask in this experiment, as the difference in pressure is sufficient to cave in a weak glass. There is always much excitement to see if we can drive the water all of the way down.

But we are by no means finished, the climax is yet to come. Ask which of the two clamps should be opened

first. Is there any danger of an explosion? Is it possible to drive water back up the long tube? Finally, we decide, for the sake of the less reckless members of the class, that we open, slowly and carefully, the clamp at the top of the long tube. We do, and the water at the bottom of the tube starts to boil. Is the water really boiling? Finally, the Club decides that the bubbles are air, and that because some of the water was driven out of the flask and tubes in the form of steam, air will enter until the pressure inside is equal to that outside.

This is just one of the many stunts that depend upon the pressure of the atmosphere. Some member of the club will be ready with another for the next Thursday.

IN MEMORIAM.

Report of the Necrology Committee of the Central Association of Science and Mathematics Teachers.

FLORIAN CAJORI

The Central Association of Science and Mathematics Teachers as well as SCHOOL SCIENCE AND MATHEMATICS has lost a true friend and a wise councilor in the passing of Professor Florian Cajori, who died at Berkeley, California, on August 14, 1930. He was an honorary member of the Central Association for more than sixteen years, having been elected to this honor at the Des Moines meeting, November 28, 1913.

Professor Cajori was born on February 28, 1859, at St. Aignan, Switzerland. He came to the United States in 1875 at the age of sixteen. In 1833 he received the B. S. degree from the University of Wisconsin and a year later took graduate work at Johns Hopkins University. From 1885 to 1889 he was on the faculty of Tulane University. For the next twenty-nine years he was connected with Colorado College, first as professor of physics, subsequently taking the chair of mathematics, and in 1903 becoming dean of the department of engineering. It was here at Colorado College that he wrote and published his first editions of his *History of Mathematics* and *History of Physics*—two books known to every real teacher of these subjects. In 1918 he was called to the University of California as professor of the history of mathematics. At the 3rd Cincinnati Meeting (1923–'24) of the American Association for the Advancement of Science he told me in a personal conversation that so far as he was able to determine he was the only man in the world who held a full professorship in the history of mathematics. The last dozen years of his life was spent primarily in writing and research in his chosen field. As Professor David Eugene Smith states in his obituary in Science (Sept. 19, 1930) Florian Cajori is the most prolific and best-known writer in the history of mathematics that this country has produced. A teacher—a scholar—a gentleman—when will America again produce his equal!

EDWIN W. SCHREIBER.

Stephen Alfred Forbes, Ph.D., LL.D., 1844–1930.

Dr. Forbes was one of the honorary members of The Central Association of Science and Mathematics Teachers who passed away during the last year.

He was born on May 29th, 1844, at Silver Creek, Stephenson County, Illinois. He received less than three years of formal education beyond the elementary school. He was in the army for four years and on active duty during almost the entire period of the civil war.

He received the degree of Ph.D. from the University of Indiana in 1884 and the degree of LL.D. from the University of Illinois in 1905. At the time of his death he was Chief, Illinois State Natural History Survey, and Professor of Entomology, Emeritus, University of Illinois. He made over five hundred published contributions to science. He was an international figure; he was awarded in 1886 the first class medal of the Société d'Acclimatation de France, for scientific publications.

The vitality and enthusiasm that he put into his work is almost without parallel. Most men at his age would have been anxious to retire, but he continued with the same strenuous application. Within the last few months he was responsible for the establishment of a plant disease survey within his organization. He was actively engaged in his work up to within nine days of his death on March 13, 1930, at the age of 85 years, 9 months and 13 days.

His interests were broad, including art, drama, literature and philosophy. Some would call him the American Huxley, but others who knew him best prefer to have him stand on his own reputation and achievements. P. K. Houdek.

William E. Davis.

William E. Davis, whose death September 14 was widely regretted, was born at Wacousta, Michigan, where he spent most of his childhood years. He came of a family which for many years has been associated with educational work, thus it was natural that he should enter, in 1885, the Michigan State College in preparation for the continuance of his work.

In 1896 he received his M. S. degree from the University of Michigan and after some years of educational work in that state he became definitely connected with the Chicago school system, first at Lake View High School and later at Crane Technical High School, teaching his chosen subject, physics. He was a man devoted to his work and knew as few do how to make it at once interesting and full of substance. Beneath a surface of austerity he always had the most genuine and kind interest in his students and their advancements, an interest never diminishing despite long years of teaching.

To his efforts to a great degree was due the fine standing and quipment of the Physics department of Crane Technical High School and the excellent spirit and cooperation among its staff.

His activities, however, were not restricted to educational work only, for besides being a member of many educational societies he had an active interest in the administrative affairs of the Village of Hubbard Woods, where he was trustee during the period of 1910 to 1921, and treasurer since 1921. His work there was especially appreciated.

He is survived by his wife, two sons and a daughter.

His friends hold the memory of a man who never spoke a wounding or complaining word, who never tired of assisting his friends and students and one prodigal in good deeds.

PH. A. CONSTANTINIDES.

THEODORE LINCOLN HARLEY, 1868–1930.

Mr. Harley, Vice-Principal of Hyde Park High School and one of the most prominent Chicago teachers, died September 19, 1930.

He was born at Elwood, Illinois. He graduated from Dartmouth in 1893 and did post-graduate work at Harvard the following year. His first teaching experience was in Vermont. This was followed by two years as high school principal at Olney, Illinois, and two years as a high school teacher at Bloomington. In 1898 he entered Hyde Park High School, Chicago, as a teacher of English. Later he transferred his attention to history and finally to physics. His teaching work is best described by saying he taught girls and boys rather than subjects. He was dean of boys for several years and assistant principal for the past five years.

Mr. Harley was a co-author with Mr. Walter R. Ahrens and Mr. E. E. Burns of a *Practical Physics Manual* and contributed occasionally to various educational publications, but Chicago teachers will remember him for his untiring efforts, directed through teachers' organizations and committees, toward improving educational and teaching conditions in the city schools. He was a member of the Central Association of Science and Mathematics Teachers and served ably as vice-president in 1922. CHRISTINE K. FUCHS.

PROBLEM DEPARTMENT.

CONDUCTED BY C. N. MILLS,
Illinois State Normal University.

This department aims to provide problems of varying degrees of difficulty which will interest anyone engaged in the study of mathematics.

All readers are invited to propose problems and to solve problems here proposed. Drawings to illustrate the problems should be well done in India ink. Problems and solutions will be credited to their authors. Each solution, or proposed problem, sent to the Editor, should have the author's name introducing the problem or solution *as on the following pages.*

The Editor of the department desires to serve its readers by making it interesting and helpful to them. Address suggestions and problems to C. N. Mills, Illinois State Normal University, Normal, Ill.

LATE SOLUTIONS.

1134, 1137, 1144. *Orville A. George, Mason City, Iowa.*

1142. *Albert Schwartz, Perth Amboy, N. J.*

1144. *B. R. Buchhauser, Arthur Katz, Willis Kraemer, Martin J. Santa, Roosevelt Senior H. S., Chicago, Ill.*

SOLUTIONS OF PROBLEMS.

1145. *Proposed by Peter Drohan, Toronto, Ont.*

Find the formula for the sum of the nth powers of the coefficients in $(a+b)^n$, where n is any positive integer.

Editor: No solution was received which gave a result as requested by the problem. Several solutions were received where the solver interpreted the problem to mean

$$2^n = 1 + {}_nC_1 + {}_nC_2 + {}_nC_3 + \ldots\ldots\ldots\ldots$$

1146. *Proposed by Lu Chin-Shih, Soochow Univ., Soochow, China.*

If a line is parallel to one side of a triangle, it divides the other sides into proportional segments. Prove the case when the sides are divided into irrational segments by means of a synthetic method. Do not use the indirect method, or involve any idea of limits.

Editor: No solutions were received.

A solution by the proposer will be given in April issue.

1147. *Proposed by W. E. Buker, Leetsdale, Pa.*

Show that the sum of the 7th and the 5th powers of the first N whole numbers is double the square of the sum of their cubes.

I. *Solved by E. de la Garza, Brownsville, Texas.*

Let S_3, S_5 and S_7 be the sum, respectively, of the 3rd, 5th and 7th powers of the first N whole numbers. And let S'_3, S'_5 and S'_7 be the sums of the same powers of the first $N+1$ whole numbers. Then

$$S'_3 = S_3 + (N+1)^3, \qquad (1)$$
$$S'_5 = S_5 + (N+1)^5, \qquad (2)$$
$$S'_7 = S_7 + (N+1)^7. \qquad (3)$$

Adding (2) and (3) we get

$$\begin{aligned} S'_5 + S'_7 &= S_5 + S_7 + (N+1)^5 + (N+1)^7 \\ &= S_5 + S_7 + (N+1)^5 + (N+1)^5(N+1)^2 \\ &= S_5 + S_7 + (N+1)^5(N^2+2N+2) \end{aligned}$$

It is not difficult to prove that

$$S_3 = \frac{N^2(N+1)^2}{4}$$

From (1), $\quad 2(S'_3)^2 = 2S_3^2 + 4S_3(N+1)^3 + 2(N+1)^6$
$\qquad\qquad = 2S_3^2 + (N+1)^5(N^2+2N+2)$

Hence, $\quad S'_5 + S'_7 - 2(S'_3)^2 = S_5 + S_7 - 2S_3^2$

Hence, $\quad S_5 + S_7 = 2S_3^2$.

II. *Solved by Joseph L. Stearn, Brooklyn, N. Y.*

By continued application of the functional equation

$$\sum_{1}^{N}[f(x) - f(x-1)] = f(N) - f(o)$$

one can show that

$$1^3 + 2^3 + 3^3 + \ldots\ldots + N^3 = \frac{N^2(N+1)^2}{4};$$
$$1^5 + 2^5 + 3^5 + \ldots\ldots + N^5 = (2N^6 + 6N^5 + 5N^4 - N^2)/12;$$
$$1^7 + 2^7 + 3^7 + \ldots\ldots + N^7 = (3N^8 + 12N^7 + 14N^6 - 7N^4 + 2N^2)/24.$$

Using the above expressions for the sums, it is not difficult to prove the theorem.

III. *Solved by P. Drohan, Toronto, Ont.*

In Higher Algebra one finds

$$S_n = \frac{n^{n+1}}{n+1} + \frac{n^n}{2} + B_1\frac{n}{\underline{|2}}n^{n-1} - B_3\frac{n(n-1)(n-2)}{\underline{|4}}n^{n-3}$$
$$+ B_5\frac{n(n-1)(n-2)(n-3)(n-4)}{\underline{|6}}n^{n-5} + \ldots\ldots$$

S_n denotes the sum of the nth powers of the first n whole numbers; B_1, B_3, B_5 are the Bernoulli numbers.

Editor: See Chrystal's Algebra. $B_1 = 1/6$, $B_3 = 1/30$ and $B_5 = 1/42$.

Substituting $n = 3$, gives S_3; $n = 5$, gives S_5; and $n = 7$, gives S_7. Using the resulting expressions for the sums, one can easily show that

$$S_5 + S_7 = 2(S_3^2).$$

Also solved by *H. M. Feldman, Washington Univ., St. Louis, Mo.; Albert Schwartz, Perth Amboy, N. J.; R. T. McGregor, Elk Grove, Calif.*; and the *Proposer*.

1148. *Proposed by Walter Carnahan, Indianapolis, Ind.*

In Altschiller-Court's College Geometry, page 66, the following

statement is given, "A triangle may have two equal external angle bisectors and not be isosceles." Give a figure to illustrate and prove.

Editor: No solutions have been received.

A solution and comment will be given in April issue.

1149. *Proposed by R. T. McGregor, Elk Grove, Calif.*

A number of three digits in the scale of 7 when expressed in the scale of 9 has its digits reversed. Find the number.

I. *Solved by B. M. Lindemuth, Defiance, Ohio.*

Let A, B and C be the three digits, reading from left to right. Then

$$A7^2+B7+C=C9^2+B9+A.$$

Hence $48A=2B+80C$, or $3A=B/8+5C$.
Now A, B and C are integers; then 3A is a whole number. Hence, $B/8+5C$ must be a whole number. For this to be true, B must be 0 or a multiple of 8. But 8 does not exist in the scale of 7, and B must be 0. Then $3A=5C$. The smallest integers that satisfy this equation are $A=5$ and $C=3$. Hence the digits are 5, 0 and 3.

II. *Solved by F. A. Butler, Jr., San Jose, Calif.*

By the same method as used in Solution I, the equation $3A=5C$ is obtained. Then $C\equiv 0 \pmod 3$, and $C=0$, 3 or 6. C cannot be 0, for then $A=B=C=0$, giving a trivial number. $C=3$ is the only possible solution. In the scale of 10 the number is 248.

Also solved by *P. Dorohan, Toronto, Ont.; M. Freed, Wilmington, Calif.; Albert Whiteman; E. de la Garza, Brownsville, Texas; W. E. Buker, Leetsdale, Pa.; Leon Filvin, Omaha, Nebr.;* and *Albert Schwartz, Perth Amboy, N. J.*

1150. *Proposed by J. K. Thornton, Fillmore, Calif.*

Three ladies go shopping. A said to B and C, give me half of your money and I can just buy that chicken; B said to A and C, give me one-third of your money and I can just buy the chicken; C said to A and B, I can do better than that, give me one-fourth of your money and I can buy it. How much money did each lady have, if the chicken was priced at \$4?

I. *Solved by Bert Norbert, Trinity H. S., Chicago, Ill.*

Assuming that the lady speaking did not use her own money, we have the following equations:

$$B/2+C/2=4;\quad A/3+C/3=4;\quad A/4+B/4=4.$$

Solving these equations gives $A=\$10$, $B=\$6$, and $C=\$2$.

II. *Solved by F. G. Tacquard, Austin, Texas.*

Assuming that each lady used her own money, we have the following equations:

$$A+B/2+C/2=4;\quad A/3+B+C/3=4;\quad A/4+B/4+C=4.$$

Solving these equations gives $A=\$1.18^-$, $B=\$2.59^-$, and $C=\$3.06^-$.

Also solved by *Hazel Fliess, Clifton Forge, Va.; R. T. McGregor, Elk Grove, Calif.; Meyer Rashbaum, North East H. S., Kansas City, Mo.; W. E. Buker, Leetsdale, Pa.; Daniel Kreth, Wellman, Iowa; Orville A. George, Mason City, Iowa; B. Lindemuth, Defiance, Ohio; M. Freed, Wilmington, Calif.; Kathryn Brown, George R. Cox, Josephine Martin, Ruth Brown, Frances Macoughtry, Attica, Ind.*

PROBLEMS FOR SOLUTION.

1163. *Proposed by E. C. Kennedy, Univ. of Texas.*

Solve for X to 5 significant figures:

$$(\sqrt{X+2}+1)^{(\sqrt{X+2}+1)}=43.5$$

1164. *Proposed by W. E. Baltzer, Battle Creek, Mich.*

Two circles intersect at P; QPR and SPT are two variable lines terminated by the first circle at Q and S and by the second circle at R and T. Prove that QS and RT intersect at a constant angle.

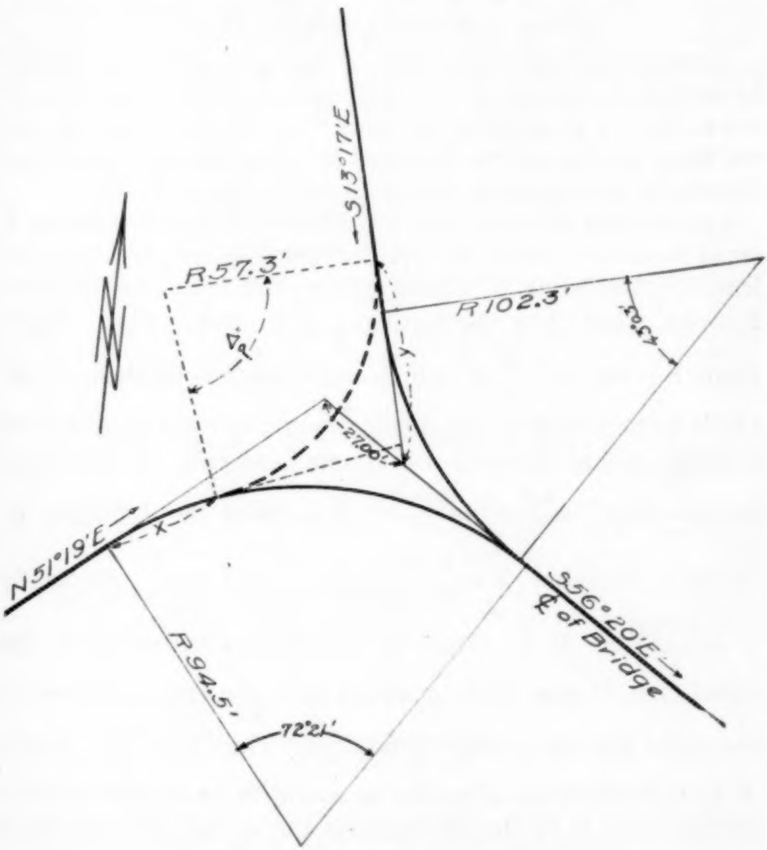
1165. *Proposed by E. B. Escott, Oak Park, Ill.*

Solve the equations:

$$X^2 - YZ = A$$
$$Y^2 - XZ = B$$
$$Z^2 - XY = C$$

1166. *Proposed by Douglas Bates, Portland, Ore.*

Two existing roads lead on to a bridge as shown. It is required to connect these two roads around the base of the cliff by a curve of 57.3 feet radius. The center of this curve will be inaccessible in the cliff, and the centers of the other two curves are inaccessible in the river.



It is required to determine curve distance designated by "X" on the diagram, the straight distance "Y," and the angle "Delta." Solve by Trigonometry.

1167. *Proposed by Albert Schwartz, Perth Amboy, N. J.*

Find a number N so that when unity is added to it and to its half, both results give integral squares.

1168. *Proposed by Leslie Hunt, Harvey, Ill.*

Some time ago I saw a silver tea set in a dealer's window. The following cost marks and retail prices were given:

Sugar bowl	hkhc	\$ 6.72	Creamer	hckh	\$ 6.00
Tray	amsl	50.16	Teapot	siab	91.08
Tongs	hblt	1.72	Spoons	hmit	10.52
			Complete	blcsk	\$166.20

Assuming the profit was the same in each case, what per cent was realized? What was the cost mark?

DETERMINING YOUNG'S MODULUS DYNAMICALLY WITH THE FOUCAULT PENDULUM.

By R. L. Edwards,

Miami University, Oxford, Ohio.

A dynamical determination of Young's Modulus similar in method to that proposed by Professor Little* has been in use at Miami University for some time. However the theory we have developed has the double advantage of rigor and simplicity as compared with that of Professor Little.

Let the bob be pulled downward extending the wire by a small distance x from the equilibrium position, and then released. According to Hooke's Law, the restoring force is $F = -kx$, where k is the force per unit of extension. Then from $F = ma$, $a = \frac{-k}{m}x$, which says the acceleration is directly proportional to the displacement from the equilibrium position so that the motion is simple harmonic. It therefore follows that $\frac{k}{m} = \frac{4\pi^2}{T^2}$ or $k = \frac{4\pi^2 m}{T^2}$. Now from the definition of Young's Modulus, $Y = \frac{\text{Force}}{\text{Elongation}} \cdot \frac{L}{A}$ or $Y = k\frac{L}{A}$ or finally $Y = \frac{4\pi^2 mL}{T^2 A}$. If L cannot be directly measured as in the usual case, it may be determined by using the pendulum in the usual way as a simple pendulum. Then $L_1 = \frac{gT_1^2}{4\pi^2}$, where T_1 is the period of vibration as a simple pendulum, and L_1 differs from L in that it includes the entire distance from the suspension to the center of oscillation rather than merely the length of the wire. Only for the case of very long pendulums or very small bobs does L_1 become approximately equal to L. When this approximation is permissible, the resulting formula becomes $Y = \frac{mg}{A}\left(\frac{T_1}{T}\right)^2$, which is identical

*School Science and Mathematics, December, 1930, p. 1060.

with Professor Little's formula, though somewhat different in form.

The mass of the bob at the Miami Laboratory is about 23 kgm., the up-and-down period about a third of a second, the simple pendulum period about seven seconds, and the wire number 21 gauge. As may readily be seen, the only sources of error aside from the approximation in the formula, are in determining the periods and in measuring the cross-section of the wire. Much more satisfactory results are obtained than with the usual static methods of measuring Young's Modulus, and the students find the experiment an interesting application of the abstract principles of mechanics.

SCIENCE QUESTIONS.

A Column of Co-operation.

Conducted by Franklin T. Jones, 10109 Wilbur Avenue, Cleveland, Ohio.

Co-operation is the **process** of **Give and Take**. What can you give? What would you like to take? Please help to make this a real **Department of Co-operation.**

INERTIA—A TOPIC OF GENERAL INTEREST.

575. *Mrs. W. H. Gallt of Geneva, Ohio, asked the Editor this Question.*

"How can I describe *inertia* to the members of our Ladies Reading Society? We are reading Floyd L. Darrow's Book, *The New World of Physical Discovery* and I must talk for 5 minutes on **Inertia.** What shall I say?"

Please send in "*A 5-Minute Talk on Inertia*" for Mrs. Gallt. (Members of the Hawarden High School Physics Class, Please Note. Also other Science Clubs and Classes.)

NEWS ITEM.

Three Men Push 208-ton Engine.

By United Press.

Boston, Dec. 22, 1930.—Although weighing 417,500 pounds—slightly more than 208 tons—a new type locomotive placed in service on the New York, New Haven & Hartford Railroad can be pushed along a stretch of level track by three men.

The huge engine will be used for experimental purposes on a freight route between New Haven, Conn., and New Bedford, Mass. It is equipped with a new type of bearings.

576. (1) What is the "Inertia" of this engine—208 tons?

(2) What is the *friction* of this "new-type of bearings"?

(3) What is the *horse-power* of these "three men" who push the engine along the level track?

(4) What is its *momentum* when at rest? When pushed along the track? Where did the momentum come from?

ANOTHER PROBLEM OF INTEREST.

577. *Proposed by Sudler Bamberger, Harrisburg, Pa.*

A motorist glides down a steep hill. When he reaches the bottom he suddenly becomes aware that his car is moving on perfectly smooth ice. He applies his brakes locking the wheels. What effect has this on the car? (Tell the "why" of these "effects."—EDITOR.)

WANTED—HIGHRITER'S PHYSICS TESTS IN FRENCH.

552. Highriter's Tests in Physics (Electricity and Magnetism) were published under this number in the February, 1930, number of SCHOOL SCIENCE AND MATHEMATICS. In the June, 1930, number of "L'Enseignement scientifique," (3 Rue Thenard, Paris 5e), pp. 277-279, is given "Une Experience Comparative" by M. Ginat. This account does not give the French translation of the questions but does give a description of the "Composition" and the "Examen" with which Highriter's "Test" was compared. These results are compared (page 278, *L'Enseignement scientifique,* Juin, 1930) by four curves A (Moyenne-mean); B (Composition); C (Test); and D (Examen).

The following conclusion is reprinted as given by M. Ginat: "Il semble que les conclusions soient aisées Ni la composition (courbe B), ni l'epreuve d'examen (D) n'ont permis d'atteindre la valeur réelle des candidats; en admittant que celle-ci soit exprimée par la moyenne (A) Le test a fourni des résultats plus corrects," etc.

Oliver J. Worthington, Banning Union High School, Banning, Cal., says:

"Yes, I would like a copy or two of Gordon Highriter's Tests in Physics in French."

The *Editor* is writing to M. Ginat asking for complete copies of *Composition, Examen,* and *Test,* and will publish them when received.

TO THE SALMON, IDAHO, BIOLOGY CLASS.

573. *C. H. Heidner, Jr., Salmon, Idaho, sends this inquiry:*

a. Which is the more expensive, the hide of the silver fox, or the hide of the Arctic fox?

b. Are there any more expensive fox hides than these two?

c. Is there any difference between the brown bear found in the Rockies and the black bear? You often see a mother with a brown and a black cub. They seem to have the same habits and are the same size.

d. How old is an elephant when it is born, or what is the period of gestation?

Answers by *Mr S. Weiss, The I. J. Fox Co., Cleveland* (known to many thousands through the "Fox Fur Trappers" of WTAM, Cleveland).

The black fox is a more expensive skin than the silver fox. Apparently, the black is a variation of the silver fox and is quite rare. Usually there is some silver in every black fox skin. The value on silver fox ranges from $25.00 to $500.00. (Prices of skins by A. B. Fuller from "Hunter, Trader and Trapper").

The Arctic fox may be a first class white in which case the value of a skin may go to $45.00. The "blue" fox of commerce is a dyed skin.

Mr. Fuller says that the true blue fox is a "color phase of the white but does not change to white." A skin may be worth up to $75.00. There is an Alaskan blue and a Greenland blue. Prices are subject to change with style.

Arthur B. Fuller, Assistant Director of the Cleveland Museum of Natural History, answers the questions about bears and elephants as follows:

The brown bear and the black bear of the Rockies are the same.

The period of gestation of the elephant ranges from 18 to 22 months. The period appears to vary even with the different varieties of elephant.

THE STEAM ENGINE.

574. *Miss Agnes H. Dugan, Plattsburg State Normal School, asks:*

Have you any literature or any material whatever on the *Development of the Steam Engine;* or could you tell me where I could obtain same?

Answer—References.

1. "*How Men Made Heat to Work*" by Franklin T. Jones, in "Community Leaflet No. 8," Bureau of Education Series D, 1918, "Lessons in Community and National Life," (pp. 75-80).

2. *Encyclopedia Britannica*, 11th Edition, Vol. 25, pp. 818-850. Article "*Steam Engine.*"

3. *The Romance of Modern Manufacture*—Charles R. Gibson—Seeley and Company, Ltd., London, 1910.

Genealogic tree of the Steam Engine (Modified from above).

1650. Otto de Guericke invented the air-pump, with its *piston and cylinder.*

1680. Christian Huyghens invented the gunpowder engine, in which the *explosion produced a vacuum* beneath the piston in a cylinder, causing the atmosphere to *force down the piston and lift a weight.*

1690. Denis Papin suggested the *use of steam* in place of gun-powder to produce the necessary vacuum.

1698. Thomas Newcomer added *a separate boiler*, so that steam did not have to be generated for each stroke. *He applied the lifting power to work a water pump for mines.*

1769. James Watt added a separate vessel in which to condense the steam, and he *made use of the expansive power of steam* to move the piston in both directions. This was the invention of the steam engine as we know it now.

1790. Watt's engine came into practice.

4. *The Romance of Modern Mechanism*—Archibald Williams. Chapter XII—The Machinery of a Ship.

5. Please send in your best references to supplement the above list.

WHOM DO YOU NOMINATE?

569. *Proposed by A C. Norris, McClure, Ill.*

Norris says:

Write to some leading man in his profession asking him to submit from 15 to 30 questions covering their field of activity along the line of Science, both physical and biological.

Dear Dentist: Give me 25 questions covering the field of dentistry.

Dear Criminal Lawyer: Submit 20 science questions you would ask a young man entering your office as apprentice.

Dear Blacksmith: A boy wishes to enter your shop; give me 20 questions he should be able to answer about iron, steel, fuels and related topics.

Norris nominates to send questions:

Dr. H. Victor Chase, Dentist, 502 National Bank Bldg., Marion, Ind

Attorney Frank Welsh, County Prosecuting Attorney, Rockford, Ill.

F. G. Norris, Chemical Engineer, American Rolling Mill Co., 269 Yankee Road, Middletown, Ohio.

J. J. Miner, Apparatus Salesman, Chicago Apparatus Co., Decatur, Ill.

Dr. H. W. Fitzpatrick, Physician, Elwood, Ind.

J C. Packard, 7 Dana St., Brookline, Mass., writes:

"Dr. Harold E. Dyer, 1368 Beacon St., Brookline, Mass., an upstanding young dentist—is concocting a list of questions for you *a la* Norris' excellent suggestion."

A UNIT TEST ON LIGHT.

578. *Prepared by L. Paul Miller, Head of Science Department, Scranton High School, Scranton, Pa.*

JUNIOR A PHYSICS—LIGHT.

In the space after each of the following statements, write the letter "O" after each one you believe false, and a plus sign after each one you believe true. Show all calculations for problems ON THE BACK OF THIS PAPER. Problems are marked (Prob.)

If two lamps give the same intensity of illumination on a screen, the lamp of greater candle-power is farther from the screen.
The velocity of light is about 186,000 miles per second.
The speed of light is greater in air than in glass.
Angle of refraction is always less than angle of incidence.
A beam of light passing from any medium into any other, is always bent toward the normal.
The image formed by a camera lens on a film is a real image.
The image formed on a motion picture screen is a real image.
Light waves are transverse waves.
Intensity of light varies inversely as distance from source.
If this paper is held two feet from a 40 candle power light, 20 is the illumination of the paper, in foot-candles. (Prob.)
Wave length of X-rays is less than of light waves.
Near-sighted eyes require concave lenses (speed of light in air.)
Index of refraction equals (speed of light in other substances.)

FOLD PAPER BACK ALONG THIS LINE:

A convex lens diverges light outward.
Lens formula is: Object distance plus image distance equals focal length of the lens.
Image in a plane mirror is always behind mirror, and virtual.
Image in a plane mirror is always same distance from mirror as the object.
In the same, homogeneous medium, light always goes straight.
Blue light cannot pass through red glass.
White light is a mixture of light waves of different lengths.
Violet light waves travel faster than red light waves.
Violet light waves are shorter than red light waves.
A bright-line spectrum is formed by incandescent gases.
Dark lines in the solar spectrum are known as Fraunhofer lines.
Image in a convex mirror is always virtual, and inverted.
Length of image—Image distance. Length of object—Object distance, in mirrors and lenses.

FOLD PAPER BACK ALONG THIS LINE:

Light is refracted more, from air to fresh water, than to salt water.
A converging lens is thicker at the edge than in the center.
Light passing from air to water, is bent toward the perpendicular.
Refraction of light, is reflection without distinct images.
A 25 candle-power light, 100 cm. from a screen, gives the same illumination as a 16 candle-power light 80 cm. away. (Prob.)
If a 1 candle-power light is 2 feet from a screen, it gives the same illumination as a 10 cp. light 40 feet away. (Prob.)
Incident ray, normal, and reflected ray, lie in the same plane.
A perfectly transparent body would be invisible.
A one candle-power light one foot away, gives one-foot-candle illumination.
Roentgen rays make radio possible.
In a camera, the image is up-side-down on the film or plate.
The image on a motion picture screen is inverted with reference to the object, or film.
Lenses are used in motion picture projectors, to diffuse light.
Intensity of light varies as squares of distance from source.

BOOKS RECEIVED.

Magnetic Phenomena, An Elementary Treatise by Samuel Robinson Williams, Professor of Physics, Amherst College. First Edition. Cloth. Pages xxii+230. 14.5x23 cm. 1931. McGraw-Hill Book Company, Inc., 370 Seventh Avenue, New York. Price $3.00.

The Nature Almanac, A Handbook of Nature Education published by The American Nature Association. Cloth. Pages viii+399. 15x21 cm. 1930. Washington, D. C. Price $1.00.

A Survey of National Trends in Biology by Edward J. v. K. Menge, Director of the Department of Animal Biology in Marquette University, Milwaukee, Wisconsin. Cloth. Pages ix+156. 14x19.5 cm. 1930. The Bruce Publishing Company, 524-544 Milwaukee St., Milwaukee, Wisconsin. Price $2.00.

Experiments in Atomic Science for the Amateur by James L. Clifford. Illustrated. Cloth. 118 pages. 12.5x20 cm. 1930. Richard G. Badger, The Gorham Press, Boston, Mass. Price $1.50.

Elementary Algebra by Clinton A. Bergstresser, Head of the Department of Mathematics, Jamaica High School, New York City and Elmer Schuyler, Head of the Department of Mathematics, Bay Ridge High School, New York City. Cloth. Pages xiv+515. 12.5x17.5 cm. 1930. Hinds, Hayden and Eldredge, Inc., 5-9 Union Square, New York.

Exercises and Tests in Arithmetic Grade 3 by David Eugene Smith, Teachers College, Columbia University, William David Reeve, Teachers College, Columbia University and Edward Longworth Morss, Editor of Mathematical Textbooks. Paper. 14 General Topics and 100 Tests. 16.5x22.5 cm. 1930. Ginn and Company, Number 15 Ashburton Place, Boston, Mass. Price 28 cents.

Science Discovery Book based on Our Environment: Book Three, How We Use and Control It by Wood and Carpenter. Paper. 21x26.5 cm. 1931. Allyn and Bacon, 2231 South Park Way, Chicago, Ill.

My Work Book in Arithmetic, Book 6 by Garry Cleveland Myers and Caroline Elizabeth Myers. Paper. 160 pages. 21x27.5 cm. 1930. The Harter Publishing Company, 2046 East 71st Street, Cleveland, Ohio. Price 68 cents per copy less 25% on orders of six or more.

Work book in Algebra, Part II by Garry Cleveland Myers, Cleveland College, Western University, Cleveland, Ohio, Elizabeth J. Thomas, Patrick Henry Junior High School, Cleveland, Ohio, and Kimber M. Persing, Glenville High School, Cleveland, Ohio. Paper. 144 pages. 21x27.5 cm. 1930. The Harter Publishing Company, 2046 East 71st Street, Cleveland, Ohio. Price 68 cents per copy less 25% on orders on six or more.

PAMPHLETS RECEIVED.

Some Universal Principles of Communication, An Outline of the Fundamentals of Communication and the Relationship of Telephony, Telegraphy, Sound Pictures and Television by John Mills. 12 pages. 15.5x23 cm. August 1929. Copies sent upon request. Bell Telephone Laboratories, Inc., 463 West Street, New York.

Aircraft Radio Development. A reprint of a series of articles which appeared in Bell Laboratories Record issued to present a connected story of the development of the Western Electric aircraft radio equipment and gives a general survey of the subject which describe the development of aircraft radio in more detail. 27 pages. 18x25.5 cm. Copies sent upon request. Bell Telephone Laboratories, Inc., 463 West Street, New York.

The Relative Merits of Three Methods of Teaching General Science in the High School by William J. Klopp, Director of Teaching, Woodrow Wilson High School and Long Beach Junior College, Long

Beach, California, and Lecturer in Education in the Summer Session at The University of Southern California. 82 pages. 15x23 cm. 1930. The Central Association of School Science and Mathematics Teachers, Inc., 3319 North 14th Street, Milwaukee, Wisconsin. Price $1.00.

Expressing Educational Measures as Percentile Ranks by Francis C. Buros, Assistant in Educational Administration, Teachers College, Columbia University and Oscar K. Buros, Associate in Educational Measurements and in Economics of Education, Teachers College, Columbia University. 27 pages. 13.5x20.5 cm. 1930. World Book Company, Yonkers-on-Hudson, New York. Price 10 cents.

College Student's Knowledge of Plane Geometry by H. J. Arnold, Wittenberg College, Springfield, Ohio. A Reprint from November, 1930, issue of School Science and Mathematics, Vol. XXX, No. 8, 7 pages. 15.5x23 cm.

Diagnostic and Remedial Techniques for College Freshmen by H. J. Arnold, Director of Special Schools, Wittenberg College, Springfield, Ohio. 18 pages. 15x23 cm. Reprint from the Association of American Colleges Bulletin of May, 1930.

Final Test in High School Physics, Forms A, B, and C also Manual of Directions. Forms A and B each have 82 questions and Form C has 83. 21x28 cm. 1930. Published by the Bureau of Publications, Teachers College, Columbia University, New York. Price $2.00 per one hundred.

Cooperative Extension Work 1928 prepared by the Office of Cooperative Extension Work. United States Department of Agriculture, Washington, D. C. Price 30 cents.

Farmers Build Their Marketing Machinery, Bulletin No. 3, December, 1930. This Bulletin deals with organizations and marketing plans of national sales agencies established by farmers' cooperatives with the aid of the Farm Board. 59 pages. 15x23.5 cm. Copies may be obtained free upon request. Federal Farm Board, Washington, D. C.

The Smallness of America's Rural High Schools by Walter H. Gaumnitz, Specialist in Rural Education Problems, Office of Education. Bulletin, 1930, No. 13. v+78 pages. 15x23.5 cm. United States Department of the Interior, Washington, D. C. Price 15 cents.

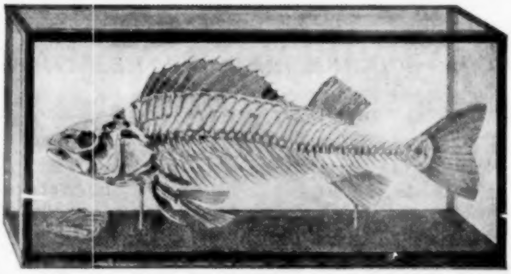
Accredited Higher Institutions, 1929-1930 by Ella B. Ratcliffe, Chief Educational Assistant, Division of Colleges and Professional Schools, Office of Education. Bulletin, 1930, No. 19. v+156 pages. 15x23 cm. United States Department of the Interior, Washington, D. C. Price 20 cents.

Accredited Secondary Schools in the United States by Margaret J. S. Carr, Division of Statistics, Office of Education. Bulletin, 1930, No. 24. v+152 pages. 15x23 cm. United States Department of the Interior, Washington, D. C. Price 25 cents.

Secondary Education in Norway by Gabriel E. Loftfield, Mount Vernon Junior College, Washington. Bulletin, 1930, No. 17. Pages ix+112. 15x23 cm. United States Department of the Interior, Washington, D. C. Price 20 cents.

Bibliography of Research Studies in Education, 1928-1929. Prepared in the Library Division, Office of Education by Edith A. Wright. Bulletin, 1930, No. 23. Pages ix+308. 15x23 cm. United States Department of the Interior, Washington, D. C. Price 45 cents.

The Fisk Teachers Agency 28 Jackson Blvd., Chicago, publishes a bi-monthly bulletin giving interesting information relative to schools, and educational progress. This is mailed free to all school and college administrative officers on request.



BOOK REVIEWS.

Science and the Scientific Mind by Leo E. Saidla, Assistant Professor of English, Polytechnic Institute of Brooklyn and Warren E. Gibbs, Instructor in English, Columbia University and Lecturer in English, Polytechnic Institute of Brooklyn. Pages xiv+506. 20.5 cmx14 cm. McGraw-Hill Book Company, New York, 1930. $3.00.

The purpose of the authors has been "to collect a body of non-technical, scientific articles of merit that will furnish interesting and profitable reading concerning the scientific mind and its relation to the many aspects of modern culture. Primarily, the book is the outgrowth of a need felt in the teaching of an advanced course in composition for students of science and technology; consequently, it has been prepared as a text book . . . . . . but it is intended also to advance the common understanding of the mind of the man of science, to clarify the meaning of science and scientific method, and to present several of the effects that science has had upon the general tone of modern life."

The selections from the writings of scientific men, recognized not only as authorities of science, but also appreciated as lucid and interesting writers, are divided for convenience and emphasis into six types—those dealing with (1) Science, (2) The Scientific Mind, (3) Scientific Motive, (4) Science and Culture, (5) Science and Civilization, and (6) Science and the Future. Just to mention some of the scientists represented in the collection, there are John Tyndall, Thomas Huxley, Frederick Soddy, Bertrand Russell and J. S. Haldane; Americans are represented by Millikan, Osborne, Slosson, Pupin and others. For classes in English composition in our technical and scientific schools the book should be a most welcome collection of some of the finest examples of scientific exposition. Topics based on the material in each article are included in the appendix. These can be used for oral discussion or as subjects for written composition. The science teacher will be glad to have a copy on the reference shelf and occasional re-reading. It will take him out of the confining narrowness of his special interest into the stimulating atmosphere of those broader fields of scientific meaning and scientific culture. R. B. Z.

Reports on European Education, Edited by Edgar W. Knight, Professor of Education, University of North Carolina. McGraw-Hill Book Co., New York. 319 pages. Price $2.25.

This is one of the McGraw-Hill Education Series under the general editorship of Edward H. Reisner. Among the several important influences that directed the course of public education in the United States from 1825 to 1850 were the reports on European education made by a small group of observers. The influence of these reports was evident particularly in the field of state control and state support of education, of compulsory education and of the training of teachers. Selections from three such reports are included in this volume. 1. John Griscom, a Quaker schoolmaster and lecturer of Pennsylvania and New York toured England and the continent in 1818 and 1819 and published his observations on conditions in the factories, mines, hospitals and educational institutions in two volumes of over 500 pages. 2. Victor Cousin, a lecturer at the University of Paris, as a member of the Council of Public Instruction in Guizot's ministry had made a trip to Germany. His report on the State of Public Instruction in Prussia exerted a profound influence on the schools in France, later in England and finally in America. 3. To Calvin N. Stowe's report to the Ohio Legislature on the elementary public instruction in Europe, reprinted in full in this volume, can be traced much of the Prussian influence in the public elementary education in several of our states. R. B. Z.

Everyday Physics, by Carleton J. Lynde, Ph.D., Professor of Physics, Teachers College, Columbia University, New York. Macmillan Company, New York, 1930. Pages xvi+577.

Everyday Physics is an enlarged and revised edition of the author's Household Physics. The student is introduced to the common devices found in the modern well equipped home—both in the city and in the country. These are used to develop and illustrate physics principles and laws. The book is clearly written and is characterized by a simple style. Its most striking and unique characteristic is to be found in its many illuminating diagrams and illustrations of household devices and systems. No high school text in physics has such complete diagrams of systems for water supply, sewage disposal, plumbing, heating, refrigeration, gas and electrical service. The author recognizes the relative increased difficulty of certain phases of mechanics and apparently believes that it is better to defer exposing the pupil to the more difficult and usually discouraging phases of the subject to the latter part of the course; and so we find acceleration and centrifugal force discussed at the end of the book. Relegating difficulties to the end of the book does not simplify them; it does however prevent early discouragement.

R. B. Z.

A Textbook of Modern Physics by Leroy D. Weld, Professor of Physics in Coe College and Frederic Palmer, Professor of Physics in Harvard College. Second Edition, Revised with 485 Illustrations. Cloth. Pages xiii+731. 14x21.5 cm. 1930. P. Blakiston's Son and Company, Inc., 1012 Walnut Street, Philadelphia, Pennsylvania. Price $3.75.

When the first edition of this text appeared in 1925 it was described by Mr. Chas. H. Smith then editor of SCHOOL SCIENCE AND MATHEMATICS as follows (see SCHOOL SCIENCE AND MATHEMATICS, Vol. xxv, November, 1925, p. 892):

"The plan of this book is excellent. It has been written in such a manner as to make the subject popular and yet, at the same time, not in any way making the subject matter cheap. The fundamentals of the subject are presented in a clear, concise and interesting manner, and in such a form of language that the average student can understand the text without any additional explanation.

"Emphasis has been put upon the physical conception of the matter discussed rather than upon the mathematical presentation of the phenomena involved. The wave method rather than the ray method has been adopted when discussing the lenses and mirrors."

The revised edition contains no radical changes; the general plan and much of the context remain as in the first edition. New matter has been included where recent developments have added new knowledge, thus bringing the text up to date. The book is of the standard type, being quite definitely divided into the usual main divisions of the subject, and following the standard order. The discussions are as clear and understandable as explanations of physical principles can be made. An abundance of problems of varying degrees of difficulty and lists of questions follow each chapter. The text has stood the test of use and will continue to be a favorite in a large number of colleges.

G. W. W.

The Nature Almanac, a Handbook of Nature Education, published by The American Nature Association. Cloth. Pages xiii+399. 15x21 cm. 1930. Washington, D. C. Price $1.00.

No other part of the elementary school curriculum is improving so rapidly as the work in elementary science. In many schools this work is unknown; in others a start has been made; in a few there is a complete course for each year. The Nature Almanac should be in every elementary school room. It tells what is being done

in each state, who the leaders are, what societies and organizations are promoting nature study and the conservation of our natural inheritance. In it you can find out about the great botanical gardens and the zoological parks, the science museums, the national and state parks. It tells what can be found for study and observations each month in the year, and gives an outline of topics and sources of information for each of the first six grades. The well-selected bibliography alone is worth more to every teacher in the elementary school and to every home than the entire book costs. The wish of the reviewer is that every teacher of children could know personally Dr. Palmer, the man who has written and compiled most of this book. To know him is to be interested in this great work he and his associates are promoting. G. W. W.

Modern Algebra (Intermediate Course) by Raleigh Schorling, Head of the Department of Mathematics in the University High School and Professor of Education, University of Michigan; John R. Clark, The Lincoln School, Teachers College, Columbia University; and Selma A. Lindell, The University High School, University of Michigan. Pages vi+343. 1929. World Book Co., 2126 Prairie Avenue, Chicago, Ill.

This book is designed for pupils who have had modern courses in mathematics in grades 7, 8, and 9, and is adaptable to a one semester course of intensive instruction or to a full year course. The subject matter is practically the same as that found in the traditional texts on pure algebra except that one chapter is given to logarithms and one to an introduction to trigonometry. However, the text has some distinctive qualities which merit the attention of the teacher interested in a text for second year algebra. The authors state in the preface that they have employed modern psychology in the arrangement and presentation of the subject. They have done this quite satisfactorily. Chapter I is devoted to a review of the essentials of first year algebra through a series of test and well motivated practice material. The text includes a number of tests which should prove very useful for instructional, diagnostic, or remedial purposes. Graphs and illustrations are emphasized throughout and make the text attractive as well as intelligible. Carefully selected groups of interesting verbal problems add another point in its favor.

George E. Hawkins.

LIBRARY READING LIST FOR GENERAL SCIENCE PUPILS.

By K. M. Humphrey,
Blodgett Vocational High School, Syracuse, N. Y.

Six years ago we felt that we needed a stimulus in appreciation of the worthwhile things of science in "regular books." A list of "150 Good Books for Freshmen Reading" was made, using the more technical books in our library for the list. This missed the point of the quest so we edited two years later a longer list of more "popular" books. This seemed to be all right but the pupils were at a loss to choose which book to read. Finally I annotated every book on the list—and some 200 more in our library—and chose the enclosed list of 239 books as the most worthwhile in our library for: 1. Interest; 2. Science; and 3. Up-to-dateness.

Our one effort is to get the pupil to read understandingly and appreciatively the science contained in good stories, travel books, etc. There are no texts or near texts on the list. There are about 40 books of fiction. Books whose annotation is followed by one asterisk (*) are considered below 9th grade difficulty. There are 80 of these. If followed by two asterisks (**) the book is considered of greater difficulty than the average ninth grade pupil can profitably handle. There are 34 of these. The pupils do not know what the asterisks are for, but their teachers and the librarian do.

Our administration of the list is explained at the top of the list. We require two books each YEAR of each pupil, and check to see that a transferring pupil reads TWO, not the same one twice! The results are really wonderful. We have enforced the requirement for six years and are more and more pleased with the ability of the pupils to "see" science when reading, to enjoy the type of books on the list—some read four or five instead of the two required—and are always smiling at the number of books on the list chosen for their English "outside" reading. The list has no influence on registration in science for General Science is required of all, anyway. No *general* use is made of the reading later, although many are the references in class of individuals to this or that in the books read.

The reading gives depth to our science work. It matures the pupils. It gives background. It allows for individual differences, especially since each teacher checks up the reading before "too late to change" to a book more suited to the pupil concerned. It affords some chance to begin vocational guidance, occasionally. Other opportunities are many. The Public Library is very helpful in its willingness to duplicate the list—at first this was embarrassing since many poor books were included, but now we welcome its cooperation.

Each pupil taking General Science is required to read each term one of the books in the list below or a similar book approved by the General Science teacher. All books listed are in the school library and most of them may be obtained also from the Public Library. On a date set by the teacher a report upon the book read is written during the science period, *without use of notes or other helps.* These reports vary as to content but may best be prepared for by: 1. Learning *the full title of the book and the author;* 2. Practicing the writing of *a brief summary of the whole book,* telling the story in a single paragraph; 3. Choosing *one or two of the most interesting incidents or descriptions* and rereading them until the de-

tails are remembered clearly; 4. Noting *the worthwhile information* gained, be it the habits of dogs, the landing speed of airplanes, the beauty of certain scenery, or whatever it may be.

Author	*Title and Description*
Adams, S. H.	THE GREAT AMERICAN FRAUD—Quack doctors and patent medicines
American Red Cross	STORY OF THE RED CROSS—Flood, famine and war relief work
Amundsen, Roald	MY LIFE AS AN EXPLORER—Arctic and Antarctic explorations
Amundsen, R. & Ellsworth, L.	FIRST CROSSING OF THE POLAR SEA—Arctic voyage of airship Norge
Atkinson, Eleanor	GREYFRIARS BOBBY—Adventures of a dog*
Bachman, F. P.	GREAT INVENTORS AND THEIR INVENTIONS —Interesting glimpses of great moments*
Baker, R. S.	BOY'S SECOND BOOK OF INVENTIONS (5 chaps.)—Radium, airplanes, lighthouses, etc.**
Barrus, Clara	JOHN BURROUGHS—A jolly lover of birds and beasts*
Barton, Clara	STORY OF THE RED CROSS—Red Cross in Johnstown flood, Cuba, etc.
Bartlett, R. A.	LOG OF "BOB" BARTLETT—Thrilling adventures in the Arctic
Beach, Rex	CONFESSIONS OF A SPORTSMAN—Good times while hunting
Beebe, Wm.	EDGE OF THE JUNGLE—Interesting wild life in the Brit. Guiana**
Beebe, Wm.	JUNGLE DAYS—Fascinating tales of jungle life**
Beebe, Wm.	JUNGLE PEACE—Wild life on South Sea Islands**
Bilby, J. W.	NANOOK OF THE NORTH—Story of Eskimo life*
Binger, Walter	WHAT ENGINEERS DO—How C. E.'s build bridges, R. R.'s etc.
Bird, R. M. E.	MODERN SCIENCE READER (any 10 chps.)—Diamonds, explosives, coal, glass, etc.**
Boecker, R. H. D.	OUR NATIONAL FORESTS—For those interested in forestry
Bolton, S. K.	FAMOUS MEN OF SCIENCE (any four)—Galileo, Newton, Davy, Darwin, Morse, etc.
Bolton, S. K.	LIVES OF POOR BOYS WHO BECAME FAMOUS —Edison, Watts, Faraday and Bessemer ONLY
Bond, A. R.	INVENTIONS OF THE GREAT WAR—Submarines, tanks, guns, etc.*
Borup, George	A TENDERFOOT WITH PEARY—Boy's adventures in the North*
Bostock, F. C.	TRAINING WILD ANIMALS—By most successful animal trainer*
Brooks, E. S.	ANIMALS IN ACTION (any 100 pages)—Habits of birds, snakes and beasts**
Brown, John	RAB AND HIS FRIENDS—A book of dogs
Bruce, Wm. S.	POLAR EXPLORATIONS—Antarctic experiences
Bryan, George S.	EDISON, THE MAN AND HIS WORK—Details of Edison's methods**
Buchan, John	THE LAST SECRETS—Explorations around the Poles, etc.
Bullen, Frank T.	CRUISE OF THE CACHALOT—Exciting voyage in a whaler

Author	*Title and Description*
Burns, Elmer E.	Story of Great Inventions—How great inventions came into being*
Burroughs, John	Birds and Bees—Very interesting personal observations*
Burroughs, John	Camping and Tramping With Roosevelt—Yellowstone; bears and other animals
Burroughs, John	John James Audubon—Biography of a great bird lover**
Burroughs, John	Squirrels and Other Fur Bearers—Very interesting stories*
Byrd, Richard	Skyward—Autobiography of Byrd's flights
Caldwell, O. W. & Slosson, E. E.	Science Remaking the World (any 5 chaps.)—Use of science in everyday life**
Chamberlain, C.	Record Flights—A sky trail to aerial achievement*
Chapman, F. M.	Travels of Birds—By an authority on birds*
Chase, A. & Clow, E.	Stories of Industry—Book I—Printing, glass, coal, iron, gold, etc.
Chase, A. & Clow, E.	Stories of Industry—Book II—Girls' book of clothing, foods, etc.
Chase, S. & Schlink, F.	Your Money's Worth—Real cost and value of what we buy
Cody, Wm. F.	Life and Adventures of Buffalo Bill—Autobiography; fights, hunting, etc.
Collins, A. F.	Air Man—All about aviation
Collins, A. F.	Book of Stars—How to know our friends, the stars*
Collins, A. F.	Boy's Book of Submarines—Includes how to make a working model*
Collins, A. F.	Camera Man—Adventures of a camera man
Collins, A. F.	Mountain Climbing—Training of a mountaineer
Collins, A. F.	Inventions for Boys—How to invent and make money at it
Collins, A. F.	Shooting for Boys—Guns, powder, shot and rules
Conklin, George	Ways of the Circus—Personal experiences of a lion tamer
Cooper, C. R.	Under the Big Top—Circus tales and circus animals*
Crump, Irving	Boy's Book of Airmen—Lindbergh and other air heroes*
Crump, Irving	Boy's Book of Forest Rangers—Fighting fire, timber thieves, etc.*
Crump, Irving	Boy's Book of Railroads—Interesting stories of work and workers
Curtiss, Glenn & Post, Augustus	Curtiss Aviation Book—Flights and future of airplane
Curwood, James O.	Grizzly King—Story of a grizzly bear
Dana, R. H.	Two Years Before the Mast—Harvard student ships as common seaman**
Darrow, Floyd L.	Boy's Own Book of Great Inventions (any 10)—Includes experiments and inventions**
Darrow, Floyd L.	Boy's Own Book of Science—Chemical magic and life of chemists
Dorling, Taprell	Sea Escapes and Adventures—Cannibalism, icebergs, hurricanes, etc.

Author	*Title and Description*
Doubleday, Russell	STORIES OF INVENTORS (any 5)—Experiences of inventors, etc.**
Doubleday, Russell	STORIES OF INVENTIONS—Typesetter, telephone, ice, etc.**
Driggs, L. L.	HEROES OF AVIATION—By one who knows the most about them*
DuChaillu, Paul	LAND OF THE LONG NIGHT—Hunting and adventure in the Arctic*
Dunlap, O. E.	STORY OF RADIO—Especially good on television*
DuPuy, W. A.	ODD JOBS OF UNCLE SAM—Birds, pickles, criminal animals, etc.*
DuPuy, W. A.	UNCLE SAM'S MODERN MIRACLES—War, census, dams, sanitation, etc.
Earhart, Amelia	20 HOURS, 40 MINUTES, FLIGHT IN FRIENDSHIP—Her own story of Atlantic flight
Eastman, Chas. A.	INDIAN BOYHOOD—Indian boy's training and playmates
Ellsberg, Ed.	ON THE BOTTOM—Raising the sunken submarine S-51*
Fabre, J. H.	LIFE OF GRASSHOPPER—Fascinating details of insect life
Fife, G. B.	LINDBERGH, THE LONE EAGLE—Life and transatlantic flight
Forbes, George	ADVENTURES IN SOUTHERN SEAS—Exciting adventures in 1600 A. D.*
Forman, S. E.	STORIES OF USEFUL INVENTIONS—Match, stove, gun, boat, carriage, etc.
Foster, Coram	REAR ADMIRAL BYRD—Life and flights across ocean and pole
Fournier, E. E.	WONDERS OF PHYSICAL SCIENCE—Biographies of *great* scientists**
Franklin Pub. Co.	NATURAL HISTORY READINGS—Battles, work and habits of animals
Fraser, C.	HEROES OF THE AIR—Flying, past and present
Fraser, C.	STORY OF ENGINEERING IN AMERICA—Exciting experiences of engineers*
French, J. L. Ed.	BOY'S BIG BOOK OF AVIATION—Great fliers tell their experiences
Gibson, W. H.	EYE SPY—Flowers, tumblebugs, frogspit, etc.*
Gibson, C. R.	ROMANCE OF MODERN ELECTRICITY (pp. 1-159)—Magnetism, batteries, telephone, etc.**
Gibson, C. R.	ROMANCE OF MODERN MANUFACTURE (8 chaps.)—How everyday things are made
Gilbert, A. C.	CHEMICAL MAGIC—Tricks with chemicals*
Gilbert, A. C.	WEATHER BUREAU FOR BOYS—Weather instruments, maps, etc.
Guidici, David	TRAGEDY OF ITALIA—Arctic rescue and flights in an airship
Gordon-Cumming, R.	LION HUNTER—Exciting hunting of lions, etc.*
Gould, A. B.	LOUIS AGASSIZ—Trials and triumphs of a biologist
Gray, Charles	"DAWGS"—Short stories about dogs
Greely, A. W.	TRUE TALES OF ARCTIC HEROISM—Unusual episodes of Arctic service*
Grenfell, Wilfred	ADRIFT ON AN ICE-PAN—A doctor keeps alive on an ice-pan*
Grenfell, Wilfred	DOWN NORTH ON THE LABRADOR—A doctor's life in Labrador

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Grenfell, Wilfred	Labrador Days—Tales of the sea toilers**
Grey, Zane	Young Forester—A forest ranger's life and battles*
Grinnell, G. B.	When Buffalo Ran—Indians, the plains, and buffalo*
Hall and Chester	Panama and the Canal—Work by France and U. S.; yellow fever, etc.
Hallock, G. T. & Turner, C. E.	Edward Jenner—"Giant" smallpox and its conqueror
Hallock, G. T. & Turner, C. E.	Louis Pasteur—Story of the greatest Frenchman
Halliburton, R.	Glorious Adventure—Travel through Greece**
Halliburton, R.	New Worlds to Conquer—New "Robinson Crusoe" in South America
Halliburton, R.	Royal Road to Romance—Rollicking through Europe on $75.00
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Hammond, J. H.	The Engineer—All about engineering as lifework*
Hawkes, Clarence	Tenants of the Trees—Intimate views of birds*
Holland, R. S.	Historic Inventions (any 8)—From printing press to airplanes**
Hodgins, Eric & Magoun, F. A.	Sky High—The triumphs of aviation
Hopkins, Wm. J.	She Blows and Sparm at That!—A good whaling yarn
Hornaday, W. Y.	Minds and Manners ofWild Animals—How the minds of elephants, etc., work**
Horton, C. M.	Opportunities in Engineering—Work and opportunity of civil engineers
Howes, Paul G.	Insect Behavior—Insect cannibals, hunters, fighters, etc.**
Humphrey, Seth K.	Loafing Through the Pacific—15 months journey in tropics**

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